EVERYMAN IN HEALTH
AND IN SICKNESS.

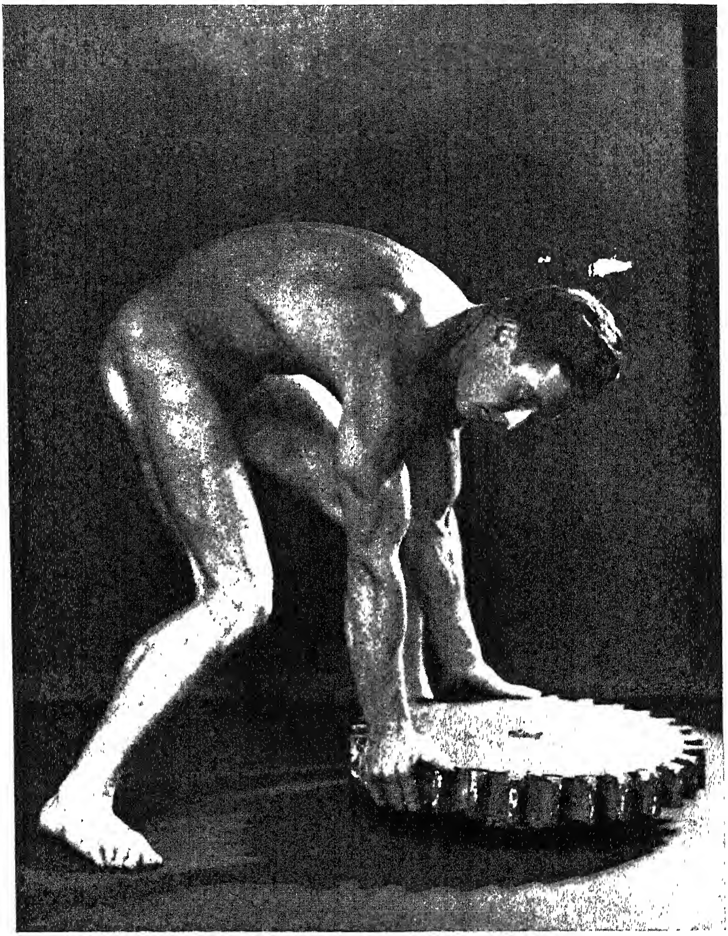

Photo by Herbert Williams

ECONOMY OF EFFORT

All muscles—arms, trunks, and legs—acting together to lift weight

EVERYMAN IN HEALTH AND IN SICKNESS

Edited
by
DR. HARRY ROBERTS

Illustrated with 32 pages of photographs
and numerous drawings

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Introduction

THE problems of health and disease concern every one, and interest nearly every one; yet there are few subjects about which ignorance is more widespread. Nor is this ignorance limited to any one class; the ideas and superstitions of the 'educated' being little less absurd than those of the illiterate. For this intellectual confusion, doctors are in part to blame. They have, through the centuries, been popularly credited with powers and with knowledge far beyond those which they could justly claim. The practice of medicine, consequently, has tended to become a mystery, based on secret doctrines known only to the initiate. That, however, is not the attitude of the leaders of the medical profession of to-day; and for the persistent misconception of the lay-public they cannot be held responsible. Doctors now realize, more clearly than do other people, that in the pursuit of health and in the fight against disease the individual man and woman must consciously and intelligently participate, if success is to be attained. Without widespread knowledge, true hygiene cannot flourish. We cannot safely rely on our instincts for guidance; for our primitive reactions are no longer apt to an environment which we have changed out of all recognition. Every one agrees that the owner and driver of a motor car should understand something of its mechanism, of the care needed to maintain it in a state of efficiency, and of the signs which suggest the expediency of taking it to a garage for expert attention. Surely the possession of similar knowledge by the owner of that much more complicated and personally valuable engine, the human body and mind, is equally desirable. It has recently been said that the average length of human life could be increased by not less than fifteen years, if more people knew what is already known by some, and if the knowledge that has been established were but applied. Ignorance, moreover, does not always take a passive form, or, at any rate, does not always lead to passivity. In the absence of knowledge, man readily becomes enslaved by didactic clichés—often traditional truths which time has turned into fallacies. The result is that popular hygienic notions are still for the most part as fantastic as they were in the days of witch-burning.

In this book, a number of doctors with knowledge and experience of the matters with which they severally deal have collaborated to explain to Everyman and Everywoman the more important of the established

facts of human physiology and psychology, and the bearing of these facts on the problems of health and sickness. The writers are not so foolish as to suppose that they can enable an uninstructed layman to 'doctor' himself and his family with the competence of a technician who has devoted years to specialist study. The aim is rather to assist the reader to understand the machinery of his body, to acquaint him with the observed laws of its harmonious working; and to help him to preserve that harmony within himself, and between himself and his surroundings, which is the very essence of health, and to enable him to recognize those slight aberrations from the normal which, when neglected, have sinister possibilities. In a word, this volume does not set out to create that crazy Utopia in which *Everyman* is *his own Doctor*. Rather it seeks to make the occasions for the doctor's intervention less frequent; and, by promoting the intelligent co-operation of the patient, to render these interventions more effective.

Why does the doctor feel the pulse? Why does he take our blood-pressure with a sphygmomanometer? What are the facts that he hopes to discover when he applies his stethoscope to our chest? How many of us could give intelligent answers to these questions? Yet, both ourselves and the physician would be helped if we could do so; for then we should better understand the nature of the problems that confront him—problems which our understanding co-operation might make far easier of solution.

All the matters dealt with in this book are treated with frankness; there is no place in the realms of physiology and hygiene for conventional reticence. The problems of sex, of marriage, of pregnancy, and of childbirth are discussed helpfully and practically. So, also, are the events peculiarly incident to the several periods of life—infancy, childhood, adolescence, middle-age, and senescence. In these pages are embodied the latest findings of biological science; yet the writers have tried to avoid the use of that jargon in which scientific knowledge is, all too often, expressed. The teaching is neither servilely orthodox nor faddily heterodox. It is believed that no other book yet published covers the same ground, or approaches the subject in the same modern and scientific, yet simple and direct way.

Popular books on physiology have generally tried to simplify the subject-matter so as to bring it within the comprehension of the previously uninstructed reader. This attempt has, however, usually led to the building-up of a picture of living man so incomplete as to be fundamentally false. The truth is that the more we have learnt about the human body and mind and their interrelations, the more complex and the more subtle these phenomena have been found to be. Those who know most about the matter at the present time are they who are most aware of the magnitude of the knowledge we do not yet possess.

There is a danger in presenting facts in too simple a way; and, doubtless, some readers new to the subject will find one or two of the sections in this book none too easy to follow at the first reading. In some instances, it may be wise for the beginner to skip these sections for the time being, and to return to them later, re-reading them in the light of the knowledge gathered from the rest of the book. Those who approach the subject for the first time will find in the earlier part of the book a sufficient account of the general working and structure of the human body to enable them to follow with intelligence the hygienic advice embodied in later chapters.

As has been explained, many recognized authorities have co-operated in the production of this volume. On matters of fact, they are agreed. On matters of opinion they may occasionally hold divergent views. It has been thought best that each writer should be left free to express his own views, based on his own experience, rather than to tone everything down to a colourless uniformity. In fact, surprisingly little difference of opinion seems to exist among those most competent to form one.

So large a proportion of current physiological and medical knowledge is relatively new that, inevitably, many of the terms employed to convey this new knowledge will be unfamiliar to some readers. Newly discovered entities and newly discovered relations between things and events naturally cannot be adequately expressed by means of words with old associations. Some terms used in this book will therefore present occasional difficulty; but the meaning will generally be clear if the context is carefully read.

H. R.

1935.

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PART ONE

THE NATURAL HISTORY OF EVERYMAN

I—SOME CHARACTERISTICS OF LIFE

Life is something quite unlike anything else that we know. It is, therefore, impossible to define it in terms simpler than its own. All we can do is to summarize some of the outstanding phenomena, experiences, and impressions which, so far as we ourselves are embodiments of life, strike us as distinguishing living creatures from non-living objects. Living things, apparently without external force being applied to them, move in space slowly or quickly, and alter their shape seemingly with purpose. In variable degree they all adapt themselves to circumstances in such ways as appear to favour their prospects of survival; moreover, they all have the strange faculty of reproducing their kind, so that, when disintegration overtakes them, similar individuals may occupy their place. Then, again, it is noticeable that all living matter is rhythmic in its activities, events recurring at approximately fixed and even intervals. Thus, our hearts normally beat some seventy-two times a minute, and we inhale air into our lungs about every four seconds; the menstrual periods of women and the limits of healthy human life afford further examples of this periodic occurrence in time. So far as we can see and understand them, the vital activities of all animals and plants are similarly rhythmic, yet, at the same time, adaptive.

It may be, of course, that the whole universe is infused with life, the manifestations of which our senses can but in part appreciate. Ultimately we are driven to introspection—that is, to looking within ourselves for anything real of which we can be sure; and it is with these internal or first-hand experiences that we are by our nature compelled to compare or contrast the impressions which all external happenings make on our minds through the intermediation of our senses. It were the merest vanity to suppose that our minds are capable of forming a true or just estimate of the universal scheme. There is good reason for suspecting that the dog and the bee—to take but two animals at random—are aware of events of which we have no knowledge or means of knowledge. He who was born blind lives in a different world from that which the rest of us enjoy or suffer. After all, our senses are few in number and limited in appreciative capacity. We hear, we smell, we see, we taste, we touch, we appreciate the force of gravity and of resistance. In the light of modern physical knowledge, what does this amount to? Certain particles stimulate

our olfactory nerve-endings. Air-waves vibrating within a certain range of frequency stimulate our auditory nerves. Activities in that suppositious and possibly non-existent abstraction named aether, within well-defined limits, so act on the retina of our eye as to produce in our minds what we call visual impressions. But, outside these limits, are realities some of which have, by the aid of scientific instruments, been recently brought within the boundaries of our sensory recognition. The ultra-violet rays of light and the X-rays are outstanding examples. Of ultimate explanations and of ultimate realities we have at present no knowledge; and it is doubtful if these things are within the potentialities of our knowledge. When we contemplate the lives of other animals and plants, all that we can see is that they exist; that they have forces within them impelling them to react to circumstances in such ways as will favour their continued existence; that they enjoy favours from Nature and suffer blows from her; that they reproduce their kind; and that, with the passage of time, their energy, their sensitiveness, and their adaptability diminish, so that ultimately they become indistinguishable from what we call the non-living matter of the world. We need not therefrom infer that life has no further meaning, or even that the phenomenon we call time has any ultimate significance; indeed, it seems likely that man's reasoning mind is adapted for little more than what we may call biological purposes—that is to say, the maintenance of earthly existence and the continuance of our species. Beyond all that we know, and probably beyond all that we can know, lies mystery. The wisest man is he who has the keenest apprehension of this mystery.

The moral would seem to be that our highest duty, as it is our highest privilege, is to develop to the utmost those faculties of mind and body with which we are endowed. In our estimation of what is highest we have but an indefinable intuition to guide us. Human life, therefore, is bound to involve frequent compromise, and frequent shrugging of the shoulders and making the best of it according to the available light.

II—A GENERAL ACCOUNT OF MAN

MAN has often been compared to a machine; but he is very much more than that. He is machine and driver and repairer and employer, all in one. For convenience of study we often separate these various aspects; and, again and again in the course of this book, the reader will come across such terms as mind, emotions, body, consciousness, and unconscious processes; but he must not allow himself to think that these are really separate and distinct things, capable of acting or of functioning independently of one another. Man is a unity, itself a harmonious blend of living unities—a harmony of greater complexity than anything devised by man himself.

MAN'S INTERNAL ENVIRONMENT

But for the discovery of the microscope we should scarcely have realized how elaborate and how subtly organized is the texture of that structure which we call man's body. The doctrine of evolution, implying as it does our relationship with the whole animal kingdom, has enabled us to unravel many mysteries by studying them in their simpler forms. We have learnt that all living creatures have much in common, however various have been the developments from the common root. One of the most revolutionary discoveries ever made by science is that man and every other animal and every plant in the world is composed corporeally of minute living entities called cells, each one of which is far too small to be seen by the naked eye; and that every individual man, animal, and plant in the world begins his or its life as a single one of these cells, which in suitable conditions divides and multiplies and differentiates according to established, and apparently predetermined, rules, until a maturity is reached, each according to kind. We have examples of every degree of elaboration, from the lowly amoeba, which lives its entire life as a single microscopic cell, and propagates its kind by dividing into two separate creatures, each an almost exact replica of its parent, to that highly developed and specialized community of cells which is Everyman. About the emotional and mental life of other animals, we can do little more than make plausible assumptions—likely guesses; but their bodily structure and their reactions to various stimuli we can observe with the help of our senses. These observations have thrown a good deal of light on the fundamental

nature of man, and on the meaning and purpose of his several parts. This does not mean that the mystery of life has been solved, or that we are appreciably nearer to its solution; for, as we resolve one item of mystery, five others, hydra-like, present themselves. Science, indeed, when properly considered, makes for increasing awe and wonder, that is for increasing reverence.

It is a curious reflection that about himself, about his own bodily and mental mechanism, the ordinary man knows far less than he knows about his motor car. The queerest notions obtain about human anatomy, human physiology, and human psychology, even among the highly cultivated. Every kind of superstition about health and disease can find a suitable soil for its implantation in all strata of society. Almost all the knowledge that has been acquired has hitherto been confined to a small specialized section of esoterics who have formed a caste apart. The practice of medicine is inevitably a matter for trained experts; but it is obviously absurd, as it is undesirable, that Everyman, entrusted, as he is, with the driving on the high roads of the universe of the most elaborate and the most dangerous vehicle conceivable, should be in complete ignorance of the structure of the machine, of the means necessary to put and keep it in good working order, of where the brakes are situated, and of the signs that indicate the urgent need of a visit to the garage.

If we are to understand even the bodily structure of man we must go back to its beginnings. The little unicellular organism, the amoeba, lives in water. It seems likely that the primal organism, of corresponding simplicity, from which man has evolved was also a water animal, presumably living in the sea of its period. It is an interesting and relevant fact that every one of the millions of living cells of which man's body is composed to-day is also a water animal, needing for its continued existence to be constantly bathed in a saline fluid, the composition of which resembles in many ways the probable composition of the primitive sea.

In another section of this book the relation between man and his external environment are discussed in some detail. But the living units of which man's body is composed do not for the most part come into contact with these external conditions; they have an environment of their own which, in contrast to that outside us, is markedly uniform. One of the most mysterious and wonderful things in human physiology is the elaborate and highly co-ordinated mechanism, if mechanism it can be called, whereby this internal environment is kept constant. The individual cells of our body live in a fluid medium which, for present purposes, we may regard as the blood itself. From this they derive their sustenance and their air; into this they discharge the waste products of their activity. Although we, regarded as entities, are

capable of a striking degree of adjustment to varying circumstance, our individual cells are by no means so responsive or so resilient. A very slight variation in the temperature, or in the chemical composition of the fluid in which they are bathed, spells for them death. Winter and summer, in the Tropics and in the Arctic regions, the temperature of human blood varies but by a small percentage. How heat is produced and how regulated is explained elsewhere; so, also, are the processes whereby the salinity and the chemical constitution of the blood generally are kept uniform, or approximately uniform. It would seem to the fancy that there are within us well equipped chemical laboratories and highly efficient chemists, prompt in analysis and apt in adjustment, having slight relation to our consciousness, and beyond the rule of our intelligence and will.

We need to realize these facts if we are to have any rational comprehension of the nature of sickness and disease. Many of those unpleasant experiences which we call the symptoms of illness are due quite as much to the efforts of our defensive forces as to the direct irritation of our outside enemies. Some invasion by germs, or breach of tissue-continuity by alien substance, disturbs the delicate balance of our bodily colony. That in itself may well be discommoding to our consciousness. But, straightaway, the unseen healing power within us, what the ancients called the *vis medicatrix naturae*, gets to work to destroy, or to envelop, the disturbing agent; and to restore the balance thereby upset. These counter-efforts often give rise to pain and discomfort, and sometimes even to danger as great as the discomfort and danger brought about by the original disturbance itself. It will be seen how careful needs to be the physician who would play a part in this battle; for, unless he realizes the nature of the campaign, and correctly interprets the manifestations of the efforts of the attackers and the defenders, he may easily, with the best intentions, hinder, rather than help, that happy outcome of the battle at which he aims. Modern doctors, to the surprise of their often protesting patients, not infrequently endeavour, instead of mollifying certain unpleasing symptoms of illness, actually to exacerbate them, because physiological science has taught them that only thus can they hope to assist the patient's directing forces which are endeavouring to restore harmony to the complicated organism for whose unity they are responsible.

The Mind: Conscious and Unconscious

All the activities which we call vital seem to be motivated by some queer immeasurable force which we call mind. Mind, like life, is a very difficult thing to define. The word is commonly taken to imply

one or other of those higher developments which distinguish man from most of the other animals; but there is good reason for supposing that the elements of mind are to be found in even the lowest unicellular organisms. Indeed, if we accept the evolutionary theory we must perforce conclude that the mind of man and the minds of all the higher animals are but developments of the rudimentary psyche that infuses the being of the humble amoeba.

Even consciousness itself may in some tenuous form be present in every living animal cell. Modern psychological and physiological research has thrown increasing light on the wonderful adaptive regulation of our internal functions, so elaborate and purposive as to be inexplicable along what we call mechanical lines. It is not we as conscious individuals, but some purposive forces within us, that cause the heart to beat regularly and rhythmically some seventy-two times a minute; that directs an increased flow of blood to those parts of the body temporarily in need of it; that maintains our body at a nearly uniform temperature winter and summer, when our machinery is actively running as when it is almost stationary; that preserves an almost constant composition of the blood, no matter what we may eat or what we may drink. Moreover the psychologists tell us, and their arguments seem convincing, that most of our acts in response to external stimuli, and even our thoughts and tastes, are settled, not by our conscious will, but by an unknown fount of power within us to which the name 'the unconscious' has been provisionally given.

The Nervous System

In a unicellular organism, such as the amoeba, in which there is, apparently, no appreciable degree of specialization of function, there would seem to be no need for a system of intercommunication; but, so soon as the multicellular stage of evolution has been arrived at, certain cells being told off for special purposes, on the fulfilment of which the well-being of the whole depends, something of the nature of a postal, telegraphic, or telephonic service is obviously needed. In man, the most important instrument of intercommunication is the central nervous system; the headquarters of which are located in the brain and spinal cord. In these structures are grouped together an enormous number of very highly specialized cells, called nerve-cells, from which proceed not only short extensions establishing rapport with neighbouring nerve-cells, but also long fibres, after the manner of telegraph-wires, through which messages may pass from the directive centre to the motor mechanisms of the body. Similar nerves connect the receptive sensory organs with headquarters. All this is more fully described later in this book.

Photo by Herbert Williams

BALANCE

The arms used as movable weights

Our emotions are older than our reflections on them, and it is an interesting fact that we have in our bodies, side by side with that system of telegraph wires or nerves the administrative centres of which are in the brain and spinal cord, a far more ancient nervous system, corresponding with that to be found in certain lowly animals apparently possessing no brain or nervous system responsive to anything that can be called a conscious will.

This so-called vegetative or involuntary organization of nerves, though unresponsive to our will and intellect, is highly susceptible to climatic and other environmental conditions, as well as to emotional states. A few instances may be quoted. When the surrounding air is cold, the blood-vessels of our skin contract, thus exposing a smaller volume of blood to the cooling air; whereas, when the surrounding air is relatively warm, or when we are engaged in active physical work or exercise, these surface vessels dilate, thus helping to maintain the uniformity of the blood-temperature. This important adaptation is none of our willing, the regulation being effected by the force behind the vegetative nervous system, in collaboration with the so-called endocrine glands, described elsewhere in this book. Here is another example. In the face of imminent danger or of aggression, we commonly experience the emotion of fear or of anger. The physical phenomena which accompany these emotions are significant. We commonly speak of a man as being pale with fear, or pale with anger. What has happened is this: endocrine glands called the adrenal bodies, which are intimately related to the vegetative nervous system, instantly produce an increased—though still minute—amount of a very potent drug called adrenalin. This drug passes into the blood, and causes in an amazingly short time a contraction of the blood vessels of the skin and of the digestive organs, at the same time dilating the blood-vessels that feed the muscles of the limbs and the muscles of the heart. We experience a feeling of muscular tension and of energy; work which is temporarily unnecessary, such as digestion, is held up, the task of the moment being to flee or to fight. At the same time, supplies of energy-making fuel are liberated into the blood from our great store-house, the liver. All arrangements are made promptly and in order as for a campaign. Here again, our conscious will takes little or no part in the work of organization; yet it would be using the word 'mind' in a very narrow sense if we excluded it from participation in these organized and obviously purposive proceedings.

The Circulation of the Blood

An organized community obviously needs not only a system of intercommunication, but also a transport system for the conveyance of actual materials to and fro. It is impossible to form a coherent idea of the organization and workings of our body unless we have in our mind a clear picture of this transport system.

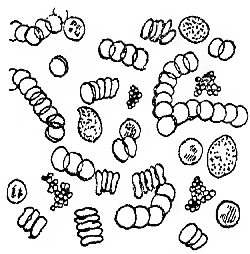
That which, within our body, takes the place of the canals, roads, and railways of our country, is the blood-circulatory system. This is described in some detail elsewhere in this book. Here, it may suffice to say that through every part of the body runs an elaborate arrangement of tubes through which blood is constantly being pressed forward; the main pressure is exercised by the recurrent contractions of a sort of muscular ball, the heart, from which proceed large tubes or vessels through some of which, called arteries, blood is, some seventy-two times a minute, squeezed onwards, whilst, through the others, the large veins, blood is poured back into the heart, ready, in turn, to be pumped out into the arteries. All of these large vessels branch and ramify, the ultimate branchlets being so small as to be invisible to the naked eye.

The heart is divided into four compartments, two on its left side, and two on its right. On each side there is a receiving-chamber and a pumping-chamber. Between the receiving-chamber and the pumping-chamber on each side there is a communicating door, opening one way only; but between the two sides there is no direct communication. The big artery from the left pumping-chamber conveys blood to its branches which are distributed throughout the body. This blood is returned through veins to the right receiving-chamber; thence it passes to the right-hand pumping-room, the arteries from which take the blood to the lungs to be aerated. From the lungs this oxygenated blood passes to the left receiving-room of the heart, whence it empties into the left pumping-chamber, and so, once again, is distributed to all parts of the body. Into the blood passes, as it circulates through the walls of the intestines, the prepared and utilizable nutriment with which our body-cells have constantly to be furnished.

The blood-stream, however, not only brings to the cells the oxygen and nutriment they need, but it also, like a scavenger, carries away the waste products of the cell's life and activities to specialized organs which prepare them for elimination from the body. The blood, indeed—or the lymph which exudes from it—constitutes, as has been explained, the actual environment of all our body cells; only the outer surface of our skin and the inner lining of our respiratory and alimentary tubes being in direct contact with external nature.

THE COMPOSITION OF THE BLOOD.

The blood, however, is not just a moving fluid, like the water in a canal or a navigable river; but is to be looked upon rather as a liquid tissue of the body. It is a thickish, viscid fluid, containing a number of interesting and important ingredients. It makes up about a fifteenth of our body-weight; the average volume of blood in a man amounting to about six pints. More than one-third of the weight of the blood is contributed by millions of little solid disks called corpuscles; the size of which may be gauged by the fact that in a cubic millimetre of human blood (a millimetre is about one twenty-fifth of an inch) there are normally nearly five millions of corpuscles. These circular corpuscles are reddish in colour, the colour being due to a most important constituent, a substance called haemoglobin. The chief function of the red corpuscles is to convey oxygen from the air-cells of the lungs to the millions of cells that make up the body; and in this work the haemoglobin plays a leading part. The red corpuscles, unlike ordinary animal cells, contain no nucleus and are incapable of reproducing their kind. They soon get worn out, when they are scrapped by certain organs specially detailed for the work. The red corpuscles are not the only solid objects in the blood. Little less important, though fewer in number, are various kinds of pale cells, collectively spoken of as white corpuscles. The two chief classes of these are known as leucocytes and lymphocytes. These are larger than the red corpuscles, and have no such clearly defined form. They have many important functions to perform; one of the most notable being to engulf or otherwise destroy dangerous bacteria and other potentially poisonous particles. The fluid medium in which these corpuscles live is called the blood-plasma, in which are dissolved the various salts and nourishing elements required by the body for its sustenance and for the liberation of energy. Blood removed from the body quickly coagulates into a solid mass or clot. After a little while this clot separates into two parts, a solid network in which the corpuscles are enmeshed, and a relatively clear fluid called serum. The physiology of the blood, and of the circulation generally, is more fully described in Part I, Section VI.



NORMAL BLOOD CORPUSCLES

LYMPH.

Essentially, if not quite literally, however, the blood circulates round the body in closed tubes—the arteries, veins, capillaries, and heart. Yet the individual cells of which our bodies are composed remain the

water animals their primordial ancestors always were. They do not come into direct contact with our blood, though it is the blood that carries to them the nutriment and oxygen that they need, and takes away from them the waste which is the invariable accompaniment of vital activities. How is this transference effected? Nature has provided an intermediary agent in the form of a fluid called lymph. All the cells of our body are surrounded by and embedded in a loose or open-woven living fabric which anatomists call connective tissue. In the interspaces of this tissue is lymph; and this is the true sea in which our infinitesimal component parts live, much as their ancestors did as unicellular organisms in the primitive sea. This lymph is much like blood without its red corpuscles; though there are other differences, which we need not dwell on here. The capillaries are minute, being about one four-thousandth of an inch in diameter, with walls so tenuous that gases, water, and watery solutions readily pass through them. The lymph is essentially an exudation of plasma, or blood-juice, through these capillary walls. The cells of the body, in fact, exist in a kind of bog or swamp through which the capillary tubes run, oozing fluid as they go, and possibly re-absorbing a certain amount in exchange. The lymph which forms the fluid part of these swamps is not quite stagnant, though its movements are sluggish. Leading from these intercellular spaces is a system of lymph-tubes or enclosed canals, which slowly drains them. These small vessels join together, as do the venules or little veins, to form larger ones, all ultimately uniting into a relatively large tube called the thoracic duct, which empties its contents into one of the big veins just before the vein reaches the heart.

The course of these lymphatic vessels, however, is not unbroken; for, here and there in their course, are situated nodes or lymphatic glands which act as filtering agents. All sorts of particles, living and non-living, are held back by the lymphatic glands and, so far as may be, are by them rendered harmless. Most of us know from experience that, when we have a poisoned wound of the finger, lumps are apt to appear in the region of the elbow and in the armpit; and that, when we have a septic sore on the foot or leg, painful lumps appear in the groin. These lumps are inflamed lymphatic glands. The swelling of the glands is due to their attempt to deal with a bacterial invasion that taxes their neutralizing powers almost beyond their capacity. Their function is to prevent, if possible, the entry of dangerous germs or their toxic products into the general circulation. The lymphatic glands are, as it were, protective garrisons, well furnished with leucocytes or white corpuscles peculiarly adapted to destroy bacteria. These garrisons are placed at strategic points, and are especially numerous and closely grouped in parts of the body exceptionally exposed to bacterial invasion. Thus, at the entrance to the throat, through which all

the air we breathe and all the food we eat must enter, Nature has provided a mass of lymphoid tissue, which is often called upon to perform tasks beyond its powers. Inflamed tonsils and adenoids are familiar instances of such undue taxation. It is interesting to find that this protective lymphoid tissue placed along the course of the air-passages is arranged just beneath the surface, so as to be better able to deal with inimical particles, organic and inorganic, which are inhaled with the air we breathe, and to prevent them from getting into contact with more vital parts, and poisoning the general blood-stream.

The tissue-fluid, or lymph—for we may here consider these as practically identical—is thus a bodily substance of profound importance to the maintenance of health and vitality. It is, indeed, our true internal environment, of which the blood and the whole blood-circulatory system may be regarded as the servant. It is from the tissue-fluid that each cell in our body obtains the various materials needed for its own repair and growth, as well as the fuel and the oxygen requisite for the production of energy liberated in the course of its individual activities and of its contributions to the collective activity of the whole organism of which it forms a part. From the tissue-fluids also, cells receive those chemical messages which are embodied in the so-called hormones, manufactured in specialized organs responsive to emotional states, themselves set going by external events. Into the tissue-fluid is emptied all the cell's refuse—the dust and ashes of its domestic life. From the blood capillaries, this lymph derives its utilizable materials, and into the blood-stream it again pours those waste products which it is expedient to get out of the way before they have had time to do injury. In the lymph are, as has been said, numerous mobile white cells similar to the white corpuscles of the blood. These are active scavengers, engaged in constant warfare with microscopic parasites, such as the bacteria, and ever ready to engulf and render harmless foreign particles of all kinds. Quickly these cells assemble at seats of danger, as every one who has suffered a septic wound, however trifling, must have experienced. They make up the bulk of the defensive army in those congested battles which are associated with the process which we call inflammation. Every chink and cranny of the body contains lymph; and the more fully the physiologists are able to unravel the subtleties of its composition, the greater will be the power and the success of the arts of hygiene and of medicine.

The Excretory System

When we burn wood or coal in our grate there is always a residue of ashes composed of incombustible material. Also, our fireplaces must be provided with chimneys to permit the escape of various gases

and vapours liberated from the fuel when it is burnt. Essentially the same problems arise, and similar results ensue, when the fuel manufactured from the food we eat is burnt in the various tissues of the body; the incombustible parts—the ashes, as it were—are, it is true, separated from our food before this is distributed to our thousands of little fireplaces, so that what actually reaches these is all burnable. The ashes remain in the intestines, and are then excreted. But although the fuel that reaches our tissues is all burnable, yielding heat and energy in the process of combustion or chemical combination, the by-products of that combustion still remain to be got rid of. They are, as it were, the smoke and the steam and the true gases that domestically escaped through the chimney. These have to be removed from the working parts, for all of them are obstructive to smooth working, whilst some act as poisons, or quickly change to poisons, if they are allowed to stagnate.

It has been explained that the blood is the great carrying medium of fuel and air to all parts of the body. Arterial blood is charged with both fuel and oxygen; but, having discharged its load, the blood does not return empty. In the tissues it again loads up with the surplus water, the carbonic acid gas, and other combustion products, and clears them out of the way. The carbonic acid gas, as has been explained, is ultimately taken to the lungs whence it is breathed out into the air. Some of the by-products are worked up again in special organs, as components of utilizable substances. The rest are distributed to certain glands and organs which, as it were, pick them out of the blood and remove them from the body altogether. A good deal of the water is eliminated by the sweat glands of the skin; but the most interesting and remarkable of our eliminating organs are the kidneys. It is by means of the kidneys that most of our tissue waste and of our nitrogenous waste products are sorted out and got rid of. The cells of the kidneys have this strange property of selecting from the blood which circulates round them, not only this nitrogenous waste, but any excess of water and of various salts over and above the proportions in which they normally exist in human blood. The substances thus removed constitute the urine, which is collected in a cavity known as the pelvis of the kidney. From the kidney on each side proceeds a tube called the ureter, whereby the urine is drained into the bladder where it accumulates until a sufficient degree of tension is experienced to give rise to the conscious urge to pass the urine from the body. The canal leading from the bladder through which this discharge takes place is called the urethra. The work of the kidneys is discussed in greater detail in Part II, Section V.

III—OUR SENSES AND SENSE ORGANS

We none of us know very much about ourselves; but we are inclined to think that we know a great deal more about the world outside us than in fact it is possible for us to know. Our knowledge of things outside ourselves is confined within the limits of our sensory receptiveness. We can see some things, but there are far more things to which our eyes are insensitive. By means of scientific instruments we have learnt about the ultra-violet rays of light, and the infra-red rays; but these are invisible to us. Our retina is not adapted to receive light messages unless the wave length and the frequency of vibration of the rays fall within certain clearly defined limits. So with our ears and our nostrils, so also with our organs of taste and of touch. The ingenuity of scientists has discovered means of transforming many world-happenings so as to bring them within our range of appreciation. The microscope, the mechanisms of telephony, telegraphy, and the wireless, and the apparatus of the radiologist are well-known examples. But only in so far as these artifices bring phenomena within the normal boundaries of our inherent sensitiveness do they widen our acquaintance with the material universe. It would seem that man's equipment of mind and of body is primarily schemed to enable him to maintain his identity —that is to exist as a separate and defined individual—for a limited period of time. We have reason for suspecting that there is an element of divinity, that is of capacity for wisdom, in every one of us; but our nature is mainly an animal nature, and our knowledge of material things differs but in degree from that of our furred and feathered relatives. It is well that we should recognize not only our powers and opportunities, but also the inescapable limitations of our natural equipment.

There are certain features common to the mechanisms of all our senses. There is, associated with each, a receptive apparatus, an almost mechanical conveying instrument, and a mysterious organ situated in the brain which transforms these stimuli in such a way as to be interpretable by our mind. Usually the receptive apparatus is understandable enough. There are mechanisms devised by man not dissimilar and equally sensitive. Nor is there anything beyond our comprehension in the conveying instrument, the nerve which passes the impersonal impulse from the sensitive receiver to the appropriate cells of the brain. It is at the inner terminal that mystery lies. We can offer no satisfactory explanation of the strange phenomenon of psychic interpretation. Certain 'ethereal' vibrations are by what we call

mechanical methods directed to the retina of the eye; and impulses in themselves meaningless are transmitted through the fibres of the optic nerve to specialized cells of the brain. Then by some mystic interaction of mind and matter, we seem to 'see' men and women or trees or clouds or sheets of water. These visions we take to be realities, but we have no means of checking our inference. So with hearing, so with touch. Until the message reaches the terminal interpreter, there is nothing in this machinery fundamentally different from man-made instruments we constantly use; but we have made nothing, nor do we know of anything, remotely corresponding with those strange happenings in the brain and in the mind, the total of which makes up our conception of the world we live in.

Although the nerves proceeding from our sensory receptive organs have been given special names, there is no fundamental difference between them. They are not to be regarded as specialized or selective. If we are in a very dark room, and receive a blow on the eye, so as to send a message along the optic nerve, it is a flash of light that we seem to see. In an atmosphere that to others seems one of silence, stimulation of the auditory nerve imposed deliberately or by some local disease gives rise to the sensation of sound—a 'buzzing in the ears' or a 'ringing in the head.' Any message received by a particular brain-cell is interpreted as arising from an impression of that kind to which alone the receptive organ at the further end of the nerve leading to it is normally responsive.

Thus is explained the well-known experience of sensation referred to a foot long since amputated—the stump of the nerve which originally conveyed the foot's messages being in some way stimulated or irritated.

The Eye

Of all our specialized receptive sensory organs, perhaps the most elaborate, as it is in many ways the most important, is the eye. The whole of our surface is to some extent responsive to light; though probably far less so than is the surface of many animals less locally specialized. This diffused sensitivity, however, provokes little or no attempt at intellectual interpretation. Physiological and even emotional activities may be thus affected, but nothing that comes within the realm of 'knowledge' or of conscious thought is created by any impressions except those made on specialized sensory organs, and therefrom transmitted to specialized parts of the brain. Everything in man is wonderful, but few of his organs, according to his own estimate, are perfect. It has been said that any skilful optician to-day could make a better lens than the one possessed by the most clear-visioned of us.

The eye is a roughly spherical organ, able to be moved from side to side and up and down in its socket, beyond which its anterior part protrudes. It has a sort of rind, or wall, and contents. The most highly specialized part of the eye is a layer of tissue spread over the inner surface of the hinder part of the wall. This is called the retina, and its main feature consists of a very large number of nerve-endings of a peculiar kind, sensitive only to light-rays of varying wave-frequency. The stimuli thus afforded by light pass along fibres which together make up the large nerve called the optic nerve, in direct connection with a part of the brain solely concerned with the transformation of these messages. Most of the light-rays that impinge on the retina are reflected from material objects, and the complications involved in our mental interpretation of these reflected rays, whereby we form images or pictures of things—trees, houses, people, and so on—are such as to defy not only description, but also clear understanding. The area of the retina is obviously a very small one; and if only those rays of light which spontaneously fell on it were, as we say, visible, the field of our observation at any given moment would be a matter of inches. The picture would, in fact, be of pretty much the same size as the retina itself. We know how large a landscape can be made to reproduce itself in image on a very small photographic plate. But for the arrangement of lenses and other apparatus that makes the camera this would, of course, be impossible. A one-inch plate would take but a one-inch landscape. What we may call the mechanical part of the eye is very much like the camera. It was long ago discovered that rays of light passing through a piece of glass with a convex surface are bent inwards, that is, towards the centre of the glass's convexity. This process is called refraction, and is the basis of the optician's technique when he fits us with appropriate spectacles. Our eyes are furnished with a convex lens, differing but in material from the glass lenses of the optician. This, however, is not quite true; for the so-called crystalline lens of the eye is elastic, and by means of muscles attached to it can, within certain limits, be made more or less convex at will. This capacity for modifying the convexity according to need is of the highest value to us; since, obviously, rays of light coming from a great distance (as when we are looking at remote objects), if they are to impinge on the retina, must be refracted or bent at a very different angle from that necessary in the case of rays reflected from near-by objects. Accordingly, we automatically vary the convexity of our crystalline lens according to whether we are looking at something quite close to us, such as a book, or a piece of newspaper, or at a distant ship or mountain-top. Some people have lenses insufficiently convex to see clearly objects near them. Others have lenses the convexity of which cannot be sufficiently reduced to enable distant rays of light to be properly

refracted on to the retina. These are the sort of defects which the optician, with reasonable success, remedies.

In front of the lens is a small sac, or chamber, which is filled with a fluid called the aqueous humour, whilst between the lens and the retina lies another chamber, the semi-fluid contents of which are spoken of as the vitreous humour. The outer layer of the wall of the eyeball proper is a tough membrane spoken of as the sclerotic; and it is to a part of this membrane that we refer when we speak of the white of the eye. In front a circular area of the sclerotic is transparent to light; and this transparent part is called the cornea, 'the horny window' of the eye. Lining the greater part of the sclerotic membrane is a dark layer of tissue known as the choroid. It is on this, at the back of the eye, that the retina is based. Between the cornea and the crystalline lens is the chamber containing the aqueous fluid; but at the back of this is an important membrane called the iris, with a central aperture, the pupil, the size of this aperture being regulated automatically according to the amount of light to which the eye is exposed, and also according to the distance of the object to which attention is directed. The iris is thus a sort of curtain with a central diaphragm corresponding to the diaphragm of the camera. The iris is coloured by particles of pigment, and it is this which determines what we call the colour of the eye—grey, hazel, or brown. In the very young infant, this pigment has not properly developed, and, accordingly, a young baby cannot safely be exposed to very brilliant light. Those races of man which occupy the less sunny parts of the world are usually blue-eyed, whereas those in more tropical areas generally have more deeply pigmented irises. Over the front of the eyeball is a thin membrane, called the conjunctiva, which, being reflected on itself, is continuous with the inner lining of the eyelid. It is this membrane which is usually first irritated by foreign particles, such as dust or minute pieces of steel or grit. The inflammation which is thus set up is known as conjunctivitis. At the outer corner of the eye-socket is a gland called the lachrymal gland, which manufactures the salt fluid we call tears. Normally, a little of this secretion passes slowly and continuously over the surface of the conjunctiva, cleansing it as it goes; and, at the inner corner of the eye, runs down a minute tube called the lachrymal duct, which leads to the inside of the nostril. The presence of irritating foreign particles on the surface provokes the lachrymal gland to increased activity, and the flow of tears across the eye may be greater than can be coped with by the lachrymal duct. We then say that the eye waters. Very similar is the effect of certain emotional states.

The Ear

Next to the sense of sight that of hearing provides man with his most satisfying means of contact with the outside world. As with the visions which we seem to see, so with the sounds that we seem to hear, we have no means of knowing the extent to which these impressions correspond with external happenings. The sights and sounds that we see and hear are in us; they are subjective interpretations of certain impacts on our bodies; but, for all we know, they are as much fancies as are the hallucinations of the mentally deranged. All that we know about the impulses that give rise in us to the sensation of sound is that they fall on our ears in the form of air-vibrations of varying frequency. Above and below certain limits of frequency these vibrations are not recognized by our sense of hearing; and the capacity of individuals in this matter varies a good deal.

For convenience of description the auditory apparatus has been divided into four parts. Innermost, and in every way the most subtle, is the auditory centre in the brain, a special group of brain cells, the fibres of which extend out as parts of the auditory nerve to sound receptors in what is called the inner ear. This latter consists of a small tube coiled after the manner of a snail (whence its name, the cochlea), lodged in a recess of the skull and filled with fluid. The outer boundary of this little canal is closed by a delicate membrane, separating it from the next compartment, the so-called middle ear. This chamber is filled, not with liquid, but with air. On its outer side is a tougher membrane, the tympanic membrane or drum of the ear. The tympanum can be seen with the aid of a flash-light at the extreme inner end of the outer ear-tube or meatus. Stretching across the middle ear from the drum to the delicate inner membrane is a lightly-hinged series of three minute bones, which act as levers. The aerial vibrations which fall on the tympanum are transmitted by these ossicles to the inner ear, where they cause movement in the contained fluid, to which movements the auditory nerve terminals are sensitive. Serious damage to any part of this transmitting mechanism is likely to bring about deafness, entire or partial. The air-pressure in the middle ear is automatically maintained, so that between the inside and the outside of this compartment the pressures may be kept equal. This balancing is effected through the instrumentality of a narrow passage, the Eustachian tube, which connects the cavity of the middle ear with the throat, where the opening of the tube can be seen in the neighbourhood of the tonsil at either side. When the tonsil or the pharynx is inflamed and swollen, the entrance to the Eustachian tube is apt to become obstructed, either by pressure or by becoming blocked with mucus. Air may thus be

prevented from entering the ear-chamber, the internal pressure of which accordingly falls, and the conveyance of sound from outside is disturbed or obstructed. There are, unfortunately, worse possibilities; for the inflammation in the throat—or rather, the septic infection of which the inflammation is a symptom—may spread to the Eustachian tube, and actually invade the middle ear itself. An abscess may form there, and the delicate joints of the little bony levers may be permanently deranged. The trouble, if not promptly dealt with, may spread even further.

The outer tube or auditory meatus is in direct contact with the surrounding air. This tube enables the drum of the ear to be hidden below the surface, and so less exposed to direct injury. Even so, however, it can be burst by severe blows on the side of the head, or even by a very loud noise, such as that of a near-by explosion. Such wounds of the drum, however, usually heal with comparatively little permanent damage to hearing; but this is not the case when, as a consequence of suppuration in the middle ear, the drum becomes perforated from within owing to the pressure of pus. The external shell-shaped appendage which most people mean when then speak of the 'ear' is the least important part of man's auditory apparatus. To some small extent it may help to collect aerial vibrations, but it is doubtful if our acuity of hearing would be appreciably reduced were we deprived of these sound-collectors. In many other animals they are certainly of the highest importance, especially when—as is usually the case—they are able to be moved freely in all directions.

The meatus protects the drum also from less violent but no less dangerous contacts. It is lined with fine hairs, and is furnished with numerous small glands which secrete wax. This wax forms a coating on the surface-lining of the passage, and helps, as do the hairs, to hinder the entrance not only of dust and small foreign particles, but also of flying and creeping insects. Normally, the small amount of wax produced gradually dries, and with the matter it has entrapped, works out of the ear. But sometimes, in some individuals, it accumulates within the meatus so as, ultimately, to prevent aerial vibration from reaching the drum. Partial or complete deafness results, which can, however, easily be put right if the ear be syringed with tepid water, skilfully injected by means of an aural syringe.

Continuous with the cavity of the inner ear are three semicircular canals, arranged at right angles to one another, two in a vertical, and one in a horizontal plane. These canals, which have membranous walls, encased in bone, contain fluid, and it is by impressions provoked by the shifting of this fluid that we are able to appreciate our position in space. Our sense of balance or equilibrium is mainly dependent on the healthy working of this mechanism. To disorders of the inner

ear, and consequently of the semicircular canals, fits of giddiness can often be attributed.

The Tongue and the Nose

The receptive organs of taste and smell may be considered together; for much that we commonly speak of as taste is really smell. The receptive organs of taste, the taste-buds, as they are called, are situated in the surface layers of the tongue, chiefly at its sides. They consist of minute funnel-shaped depressions, projecting into which are numerous fine nerve-endings. These nerve-endings respond but to four qualities: sweetness, sourness, bitterness, and saltness. In order to stimulate them, the substance must be in solution, either in water or in saliva. Consequently, insoluble substances have no taste. The sweet, bitter, sour, or salt solution, in order to be recognized as such, enters these little depressions, and comes into contact with the nerve-endings. The stimulus thus given is duly interpreted by the mind operating through the special gustatory cells of the brain.

Most of the sensations that we commonly speak of as taste or flavour are, as has already been said, really agreeable or disagreeable smells. People who have bad colds in the head often complain that they can taste nothing; though, as a matter of fact, they may be as discriminating as other people between the four tastes that mark the diagnostic limits of every one. Their trouble really is that they cannot smell, owing to their olfactory receptors being blocked by mucus or by the swelling of adjacent tissues. These receptors are situated in the higher part of the nostrils where they are exposed not only to air breathed in through the nose, but also to air from the back of the mouth; with which the nasal passages are connected. It is presumed that the olfactory nerve-endings are stimulated, as are the gustatory ones, by material contacts involving chemical interaction. So small, however, must often be the particles given off by the odorous body, which yet are recognizable by our sense of smell, that many people have thought it more probable that the mode of excitation of the olfactory nerve-endings has something of the character of the vibrations of light rather than of that of material entities. It is said that a gram of musk will give off its strong odour for years without weighing appreciably less at the end of the time; and that the smell of one ten-thousandth of a gram of the substance known as mercaptan (the smell-principle of the skunk) is perceptible even when it is diluted with fifty million times its own volume of air.

An epicure, wishing to get full aesthetic value out of a glass of wine or a cup of choice tea, breathes in through his mouth, after taking a sip of the liquid on his palate, and then breathes out through his nostrils. In this way he is able to get the full flavour or fragrance.

The Touch

The receptive organs on which impressions must fall in order to give rise to the sensations of sight, sound, smell, and taste, occupy a very small part of the body's surface which comes in direct contact with our external environment. But, distributed over almost the entire area of the skin are more than a million nerve-endings, sensitive to heat and cold, to touch and pressure, or to those more positive assaults which give rise to pain. The nerves which convey the messages which we interpret as heat or cold are, however, distinct from those which convey the messages of touch and of pressure. It is said that there are about a quarter of a million spots on the surface of the body receptive to the sensation of cold, and about one-eighth of that number receptive to heat. The spots responsive to the contacts which we interpret as touch or pressure are much more numerous. These latter in particular are readily localized by the mind, so that, with our eyes closed, we instantly know to a nicety what part of our surface is being touched or pressed on. The slight difficulty in discrimination that is sometimes experienced if two spots close together are simultaneously touched, depends on the relative closeness of the sensitive nerve-endings in that particular area.

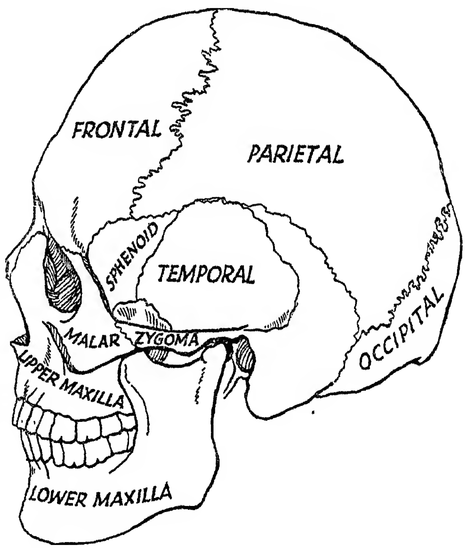
Internal Sensations

All the senses hitherto described are concerned with impulses from outside us. But we are capable, also, of experiencing sensations from within our bodies. Normally, when all is going well and smoothly, we are scarcely conscious of the reassuring messages sent to our central nervous structures from our various organs and tissues. Habitude leads to unawareness—and this is true even of many of the external impacts on our senses. The fragrance of a rose held too long to the nostrils is no longer recognized; familiarity breeds a sort of anaesthesia. When, however, there is variation in the stimuli on a nerve-ending, attention is arrested as by a sudden noise; and our consciousness wakes up. All the internal pains and discomforts we from time to time experience are indicative of such disturbances of the routine harmony that in perfect health prevails.

IV—THE GENERAL STRUCTURE OF THE BODY

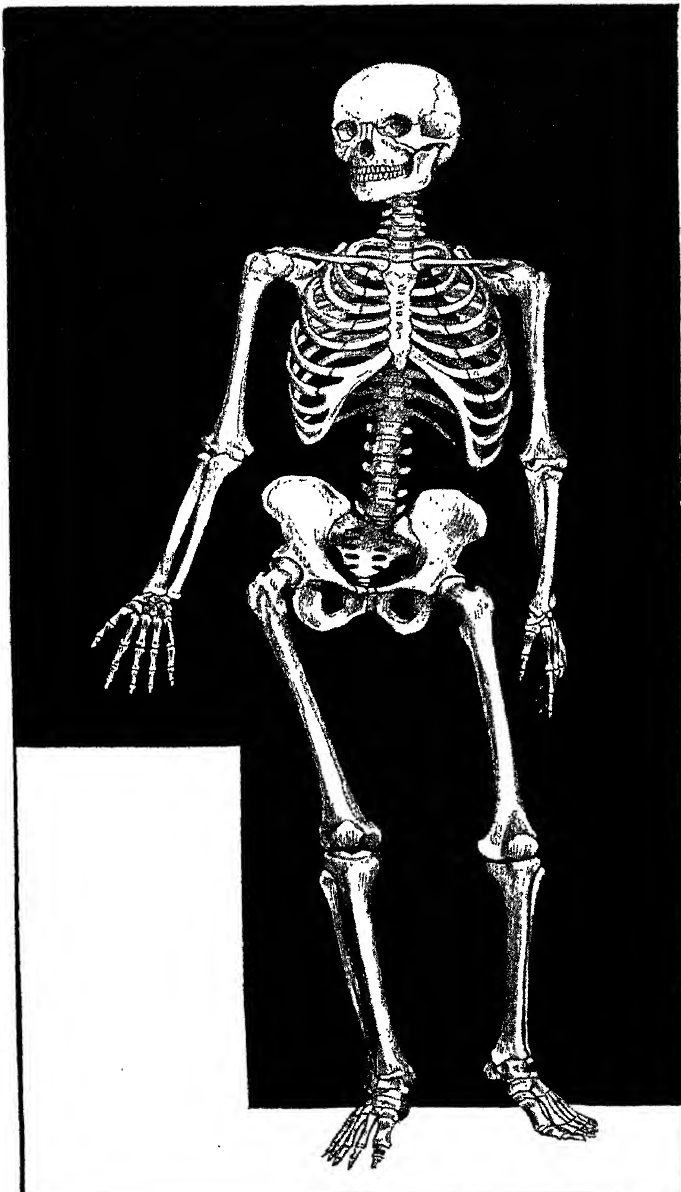
The Skeleton

The core or framework of the body is formed by the bony skeleton; and it is the arrangement of the bones that gives the body its general shape. Our progression in relation to the surface of the earth is effected by altering the relative position of these bones, which are jointed or hinged together so as to enable them to be separately moved. As we stand upright we have at the top the hollow arrangement of bones which together make up the skull. With the exception of the lower jaw these bones are in the adult so firmly jointed together that they are practically incapable of separate movement. The jointing, however, gives additional strength, and this is necessary, for within the skull is the important organizing and administrative bodily organ, the brain.



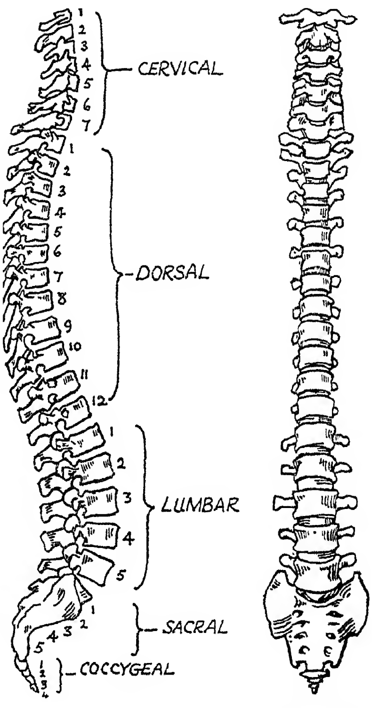
BONES OF THE SKULL
Side view

The skull rests on top of a pile of thirty-three bones, known as the vertebral column. Between the skull and the two higher vertebrae provision is made for a good deal of circular movement; but, between the remaining vertebrae little movement, beyond such as will allow a gentle curving of the body, is possible. Arching round from the higher part of the vertebral column are the slender curved ribs, which are jointed in front to a flat bony plate, known as the breastbone or sternum. These ribs, with the sternum in front and the backbone behind, form the cavity known as the thorax, in which the heart and lungs are contained. At the top of the breastbone on each side is a bone shaped like the letter '*f*,' the collar-bone or clavicle. At the posterior upper part of



THE HUMAN SKELETON

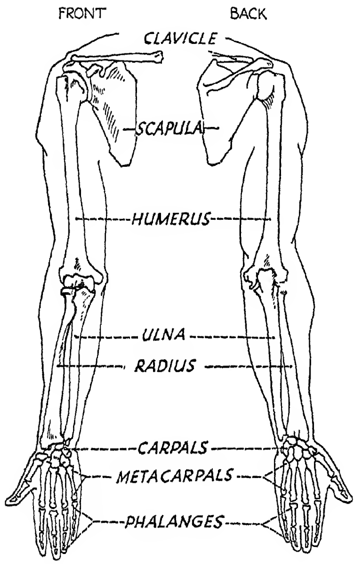
the thorax is, on each side, the flat three-cornered bone called the shoulder-blade or scapula. At the upper and outer corner of the scapula is a shallow bony socket, in which the rounded end or head of the long bone of the upper arm, the humerus, loosely fits. The lower part of the vertebral column consists of two groups of united vertebrae, the upper and larger of which is called the sacrum, the lower and smaller constituting the coccyx. In animals that have tails the coccyx constitutes the bony framework of the tail. Firmly jointed with the sacrum on each side are two strong flat curved bones, the hip bones, which unite in front; the whole forming a sort of basin, called the pelvis. This constitutes the base of the trunk, and supports the weight of the abdominal organs when we are standing upright. Each of the two hip bones has a socket, rather like that of the shoulder-blade, but much deeper; in this socket fits the head of the femur, the long bone of the thigh. On account of the depth of this socket dislocation of the hip joint is very much rarer than is dislocation of the shoulder joint.



VERTEBRAL COLUMN

The bones of the arms and legs are arranged on very similar lines. The femur in the thigh and the humerus in the upper arm are respectively jointed below to two bones: the tibia, or shin-bone, and a long slim bone, called the fibula in the leg, and the ulna and radius in the forearm. The fibula and the radius are on the outer side of their respective limbs; the radius, however, is so jointed at its upper end as to be capable not only of being folded up in common with the ulna so as to make them nearly parallel with the humerus, but also of rotation, so as to turn the hand over and bring the thumb from the outside to the inside, or vice versa, and thus permit of the hand being placed palm upwards or palm downwards. At the wrist an arrangement of eight bones, jointed on to the radius and ulna above, allow of a considerable

freedom of movement at that joint. Articulated with these carpal, or wrist, bones are five bones known as the metacarpals, which extend to the roots of the fingers and thumbs; each of the fingers being furnished with three bones, called phalanges, and the thumb with two. The ankle and foot are structures on somewhat similar lines, but the ankle, or tarsal, bones are more rigidly attached to one another, and the phalanges of the toes are shorter than are those of the fingers.



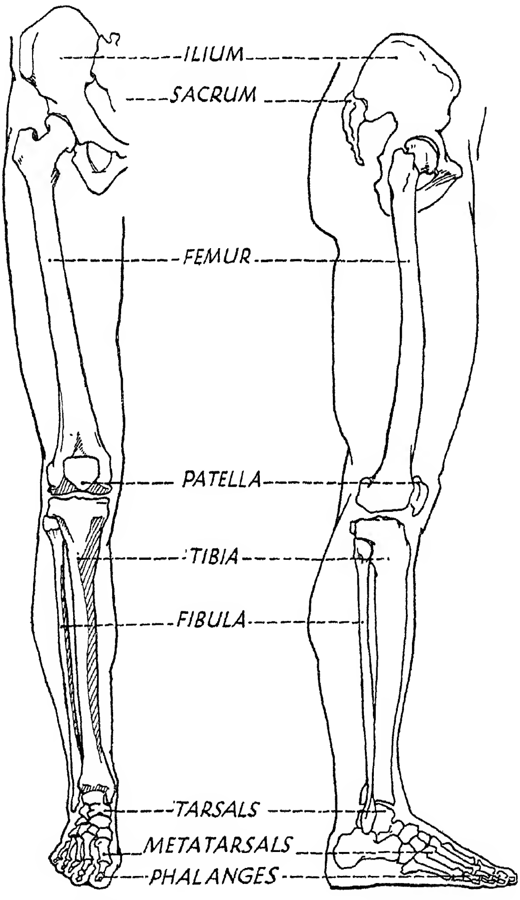
BONES OF THE ARM AND SHOULDER

Where two bones come together to form a joint there is an intermediate layer of elastic cartilage or gristle which serves to diminish vibration and shock. The whole joint is enclosed by a tough membrane, the inner surface of which 'secretes,' or produces, a lubricating material known as synovial fluid. Sometimes, when a joint is injured, the synovial membrane becomes irritated and inflamed, and produces an abnormal amount of fluid. This condition is called synovitis. The bones taking part in a joint are connected and prevented from becoming too widely separated from one another by means of tough cords or ligaments. These ligaments are attached by one end to one of the bones, and by the other end to the other bone. Most joints are also supported by the tendons of muscles, about which more will be said later. Many different kinds of joint are exemplified in the human body. Thus, at the shoulder and hip, we have examples of the ball-and-socket, enabling movements of flexion and extension and of abduction and adduction, as well as of rotation. At the knee, we have a simple hinge-joint, allowing of little more than movements of flexion and extension. More will be said about joints and their mechanism later in this book.

The Muscles

The bones themselves have no power of movement. They are moved in relation to one another by the pull of muscles. The muscles consist essentially of bundles of living fibres which, when stimulated, have the faculty of contracting or shortening. In the case of the muscles

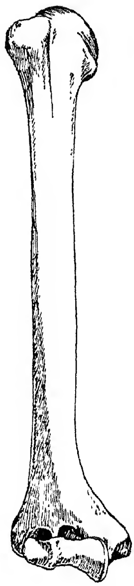
of the limbs one end of each muscle is firmly attached to one bone, and the other end to another bone. When the muscle contracts, its two ends are necessarily brought nearer together, and one of the bones to



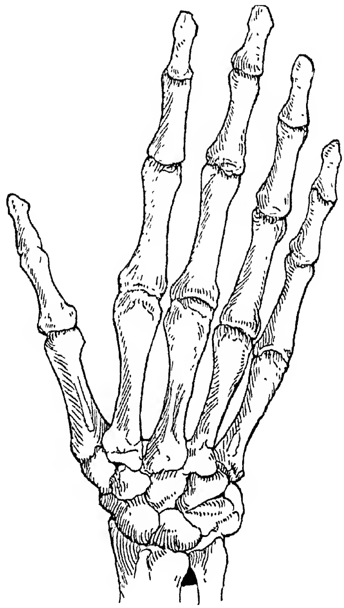
BONES OF THE LEG

which it is attached is compelled to move accordingly. To take a typical muscle, the biceps; this is attached at its upper ends to one of the shoulder bones, at its lower end to one of the bones of the forearm. When we wish to raise our forearm, as when we lift a cup of tea to our lips, a stimulus is sent to the biceps by our mind through a nerve which

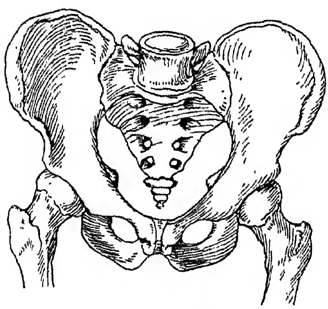
causes the muscle to contract. If, with our other hand, we grasp the upper arm whilst we carry out this manœuvre, we can feel the biceps



HUMERUS

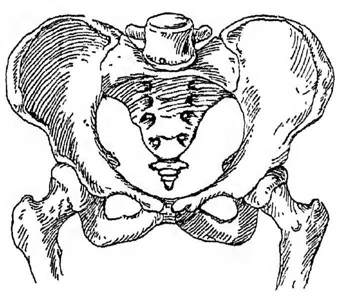


BONES OF THE HAND AND WRIST



Front view

BONES OF THE MALE PELVIS

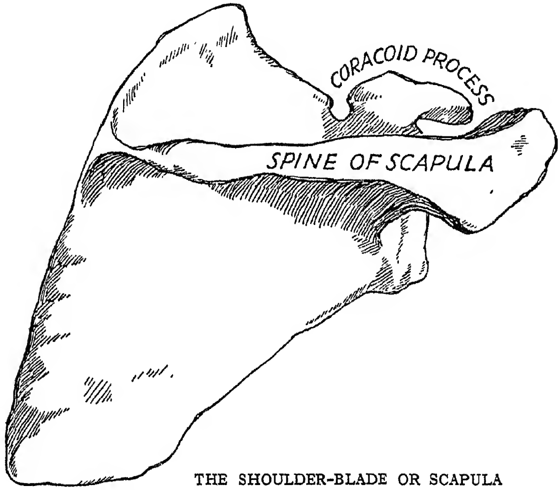


Front view

BONES OF THE FEMALE PELVIS

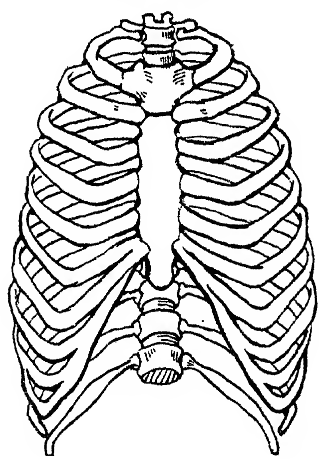
muscle thickening as it shortens. In fact, the movements of our limbs are much more complicated than this might suggest; each movement being graduated and regulated with an eye to economy and effectiveness.

This also is more fully explained in the section of this book devoted to physical exercises. In order that the muscles may do their work



THE SHOULDER-BLADE OR SCAPULA

they must be supplied with material embodiments of energy, just as must an internal-combustion engine or a steam engine. Moreover, the muscles, like all other parts of the body, are composed of living cells, which need a constant supply of nourishment, oxygen and water, to enable them to live at all. All these things are supplied to them by that common carrier of the body, the blood.

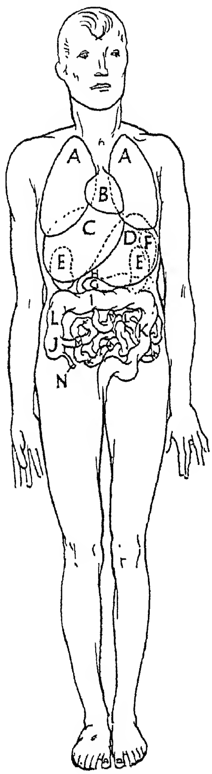


THE BONY THORAX

The Chest

The central of the three main compartments into which man's body is divided is the chest, or thorax. The bony framework of the thorax is shaped after the manner of a truncated cone. At the back are the twelve dorsal vertebrae; at the front, the sternum or breastbone, ending below in a flat piece of cartilage known as the ensiform cartilage. Arching round the chest from the vertebrae to the sternum are the twelve ribs on each side, the lower of

which are called floating ribs, because they are not attached in front directly to the sternum or its cartilage. Between the ribs lie the intercostal muscles, enabling chest movements to be effected. At its upper end the thorax is continuous with the neck; below, it is bounded by a muscular sheet, domed upwards, called the diaphragm or midriff. The thorax contains two of the most important organs in the body, the heart and the lungs; both essential to life.



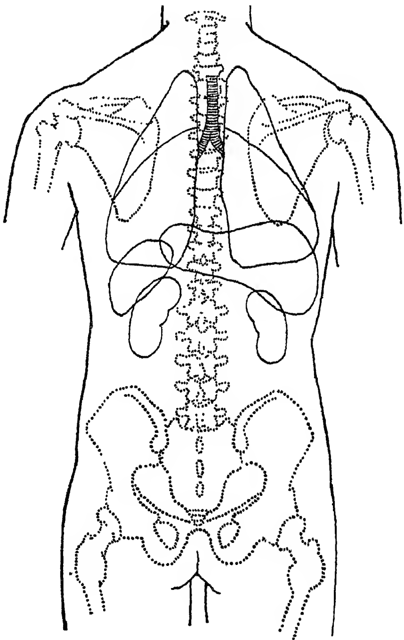
A. Lungs	H. Pylorus
B. Heart	I. Transverse Colon
C. Liver	J. Caecum
D. Stomach	K. Descending Colon
E. Kidneys	L. Ascending Colon
F. Spleen	M. Small Intestine
G. Pancreas	N. Appendix

THE LUNGS.

On entering the chest the windpipe, or trachea, bifurcates into the two bronchi, each of which again divides and subdivides into smaller and smaller tubes known as bronchioles, the smallest subdivisions of all terminating in bunches of minute bladders called air-cells. The walls of these air-cells contain numerous capillary blood-vessels; and it is while the blood is passing through the walls of the air-cells that it gives up its waste gas, carbonic acid gas, and takes in or absorbs a fresh supply of oxygen from the air in the air-cells. The importance of this purifying and re-aerating of the blood is explained in Part I, Section VI. The lungs are simply a mass of these air-cells and of the tubes leading to them, bound together by connective tissue; they thus have a very spongy feel and appearance, since air makes up a good deal of their bulk. They are covered by a membrane, called the pleura, which continues over the inner surface of the chest wall; there are thus two layers of the pleural membrane, which are separable, though, on full inflation of the lungs, in relatively close contact. So that the two layers may move freely over one another, the cells of which the membrane is composed manufacture, or secrete, a lubricating fluid, the pleural fluid. It is this membrane which sometimes becomes

infected by bacteria, as a consequence of which inflammation results, and the person thus affected is said to suffer from pleurisy. The friction between the two layers of membrane often gives rise to considerable pain, in an effort to relieve which, additional fluid is often secreted. This fluid may become infected and purulent. We then have the condition known as empyema, which is but another name for an abscess in the pleural cavity.

The act of respiration is performed by alternately expanding and contracting the walls of the chest. As the walls expand the lungs also expand, and draw air into themselves; when the chest wall contracts air is forced out. It will be seen how harmful is any form of garment that restricts in the slightest degree the free movement of the chest wall. It should, perhaps, be explained, that an enlargement of the chest cavity can be brought about, not only by the raising of the ribs and a consequent increase in the chest's diameter, but also by a lowering of the dome of the diaphragm, consequent on movements of the abdominal muscles. There is usually a noticeable difference between the breathing of men and women in the relative reliance placed on the chest and on the abdominal muscles, though this is much less marked since female fashions in dress became more sensible, and the old, rigid corset ceased to be commonly worn. The difference, in any case, is probably due far more to divergent fashion in dress and physical habits than to fundamental sex distinction.



BACK VIEW OF BODY
Showing position of organs

THE HEART.

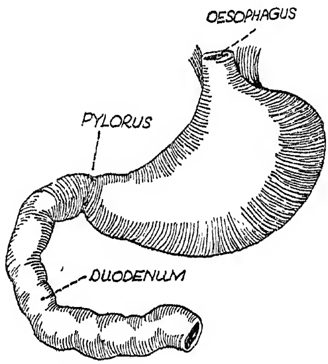
The other important organ of the chest is the heart, which lies obliquely a little to the left of the middle line. Its structure and functions have already been briefly explained; and are discussed more fully in the Chapter devoted to Circulation and Respiration. Here it

may be repeated that the heart-muscle contracts—that is, automatically squeezes itself—seventy-two times a minute, thus forcing the blood out through the arteries, the openings to which are guarded by valves which allow a one-way flow only. Many of the serious forms of heart disease essentially consist in damage to one or other of these valves which, consequently, is no longer effective. The cavity of the heart is lined by a membrane called the endocardium, which is liable to bacterial infection, with very serious consequences, and covered externally by another membrane called the pericardium. This also may become inflamed and give rise to distressing symptoms.

The Abdominal Cavity

The diaphragm forms the upper wall of the abdomen, the contents of which rest below on the basin-like pelvis. Behind, are the lumbar vertebrae, followed by the five vertebrae which are joined together to form the sacrum which is continued below as the coccyx, consisting of four small terminal vertebrae, also joined together. The abdominal cavity is lined by a two-layered membrane called the peritoneum, corresponding with the pleura of the thorax. Just as the inner layer of the pleural membrane is reflected over the surface of the lungs, so is the inner layer of the peritoneum reflected over the intestines and other structures occupying the abdomen. The upper, and larger, part of the abdominal cavity is occupied by structures concerned in the digestion of our food and the adaptation of its constituents to the needs of our tissues. The largest single structure in the abdominal cavity is the liver, which in an average adult weighs from three to four pounds. It occupies the upper part of the cavity, the bulk of it being situated to the right of the middle line. It extends up into the hollow of the dome of the diaphragm, and is almost entirely covered in front by the lower ribs and their connecting muscles. Lying against its under-surface is the gall-bladder, in which the bile secreted by the liver is collected. The functions of the liver and of its secretions are described in the section dealing with the digestive system. Opposite the liver, on the left-hand side of the upper part of the abdominal cavity, is the stomach, which is a muscular pouch shaped somewhat like a bean, and capable of distention, according to the volume of its contents. Its larger end, the fundus, is well to the left, lying under the lower ribs. Into this end the gullet, or oesophagus, which passes at the back through the thorax and diaphragm, enters. The smaller end of the stomach is situated near the middle line of the abdomen. This is known as the pyloric end; and it tapers off into the beginning of the small intestine. There is a valve situated at the pyloric orifice which regulates the entry of the

stomach-contents into the bowel. The normal healthy stomach of an adult, after a meal, has a capacity of a little under two quarts. Further dilation is generally indicative of morbid changes. The small intestine is about an inch in diameter, and about twenty-seven feet in length; it lies in coils, and occupies a considerable space in the abdomen. On the right side of the lower part of the cavity the small intestine joins the large intestine, the length of which is usually between five and six feet. Near where the small intestine and the large intestine join, is the small, blind pouch known as the appendix, which is connected with the dilated intestinal cul-de-sac called the caecum. The first part of the large intestine ascends vertically from the caecum, then proceeds across the abdomen to the left side, and descends. These parts are known as the ascending, transverse, and descending colon. At the bottom of its descent the colon again curves slightly upward; and then, like an inverted 'U,' finally descends to the rectum, which terminates in the external opening, the anus.



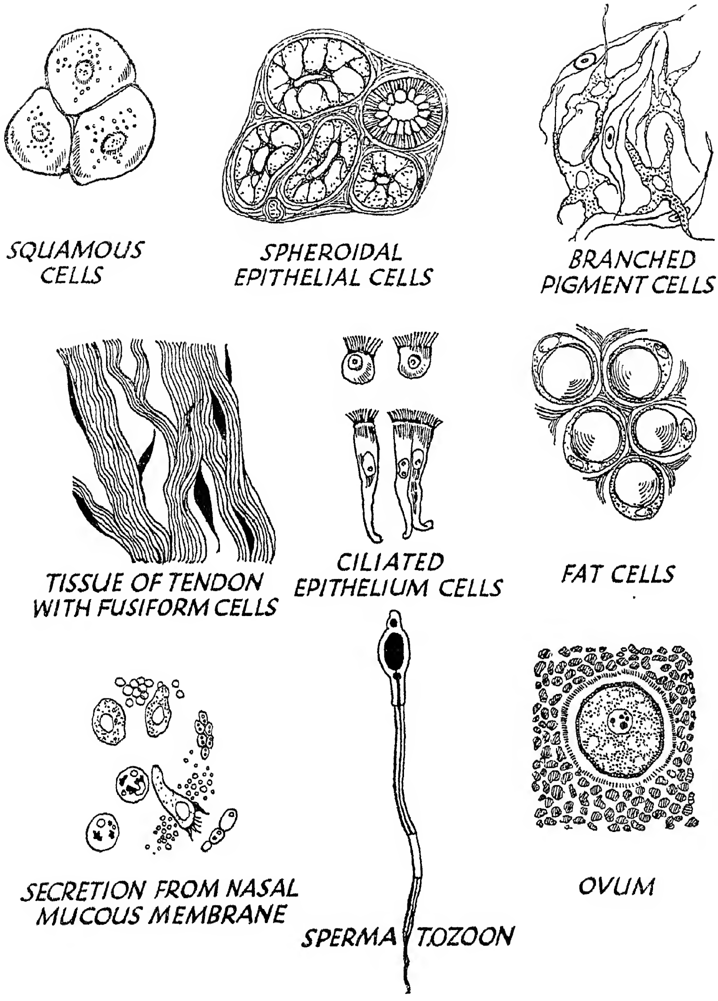
THE STOMACH AND DUODENUM

Besides the stomach, intestines, and liver, the abdominal cavity contains several other important organs. Two glands that play leading parts in the general working of the body are the spleen and the pancreas. The pancreas lies in the hollow between the lower side of the stomach and the duodenum, which is the name given to the first part of the small intestine. The functions of the pancreas are described in the section dealing with metabolism and the endocrine glands. The spleen lies on the left side rather behind the stomach, between it and the diaphragm. The function of the spleen seems to be to remove worn-out red corpuscles from the blood, to scrap them, and to prepare the utilizable ingredients for further service. It is believed that, if the spleen is removed, as it sometimes has to be on account of disease, the work hitherto performed by it is taken over by the liver; for it is a fact that life can be continued, usually with little inconvenience, in its absence. Below the stomach on the left, and the liver on the right, are the left and right kidneys, the latter being a little lower in position. Proceeding from the kidneys are the two tubes known as the ureters, which convey to the bladder the urine manufactured by the kidneys from the blood.

V—THE CELL: THE BODY UNIT

A word that again and again occurs in this book is 'cell.' Every living plant and animal is composed of conglomerations of minute particles, whole groups of which are practically identical in appearance and size. Man is no exception. These particles are so small that they can only be seen when highly magnified by the microscope. They are usually composed of a glutinous material, and sometimes are surrounded by a slightly tougher layer constituting a kind of wall or rind, known as the wall. Often, however, they have no such covering. The corpuscles that exist in the blood are examples of isolated cells; but our skin, our bones, our muscles, and our brain are all made up of tens of thousands of essentially similar cells, much as a wall or a pillar is often composed of bricks. Each cell contains a slightly differentiated core, known as the nucleus, embedded in the glutinous matrix already referred to.

Cells have the curious faculty of being able to divide themselves into two—each of the two new cells thus formed being usually indistinguishable from the parent cell. When a cell is about to divide, the nucleus becomes elongated, and its substance distributes itself into a number of infinitesimal rods, to which the name chromosomes has been given. The number of chromosomes in the cells is uniform in every cell forming part of the body of any given species of animal. When a cell divides into two the nucleus also divides, leaving each daughter-cell equipped with the full number of chromosomes. There is, however, one exception to this rule. In those species of animals, such as man, in which the individuals are of two sexes, the female, at certain stages of her development, produces at intervals reproductive cells or ova. The mother-cell of an ovum divides into two, as do other cells, but each cell thus produced is equipped with only half the usual number of chromosomes. Exactly the same phenomenon is found in the reproductive cells of the male, known as spermatozoa. A new individual is created when a spermatozoon unites with an ovum, which is then said to be fertilized. This new compound cell is furnished with the full complement of chromosomes, half of which are derived from the female germ-cell and half from the male germ-cell. Each one of us began his career as such a fertilized ovum. In suitable conditions this ovum divides into two, each of these halves again into two, and so on, until a mass of embryonic tissue is produced. At some stage of this development, agencies, about which as yet we know very little, cause a



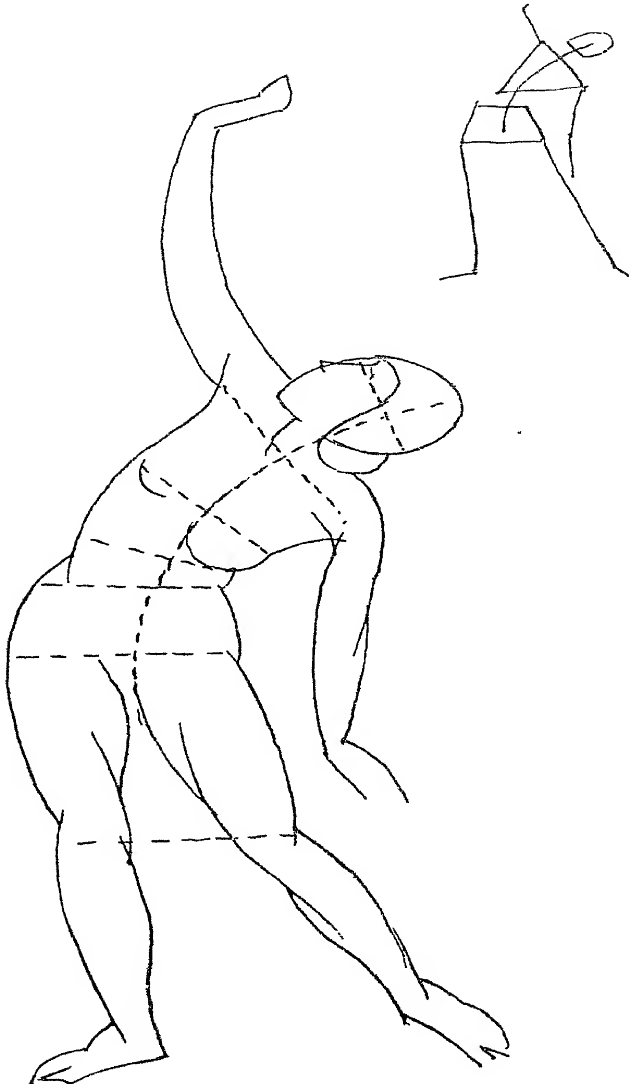
TYPES OF CELLS

differentiation to occur, so that certain daughter-cells no longer exactly reproduce the character of the cell from which they are immediately descended. Gradually organs and limbs begin to be formed, and these continue to grow until they reach a certain size, when further growth is checked. With our present knowledge we cannot, however, form an adequate idea of how this growth and development is organized and restrained within such clearly defined limits. At the end of nine months a new fully-formed human child appears in the world, equipped with arms and legs and eyes and ears and all the thousand specialized organs and tissues which go to make up the body of man. But this is not all the magic; for the infant, though without any first-hand experience of the world about it, begins straight away to exercise mind, and to make purposive movements calculated to secure its continued existence. Though it may not be what we call conscious, it already has knowledge. In simple ways it soon acts in a manner which in an adult we should attribute to reason. It grasps a support with its hands; it applies its lips to the nipple of its mother's breast. It has sensations and emotions—or, at any rate, acts in ways that we normally assign to such mental happenings. There is nothing in inorganic nature comparable with all this; and we may safely say that the difference between a living thing and an unliving thing is that the former possesses mind. We must not confuse this strange force or quality with any of our bodily structures, such as the brain or the nerves, important instruments though these are. Animals that have no stomach or intestines digest their food; creatures that have no lungs take in oxygen and give out their waste gases. Organisms that have no specialized generative organs reproduce their kind. Our organs but provide increased efficiency for our functions. Growth and differentiation continue for many years after birth, but ultimately there comes a limit to these processes. Growth ceases, and no, or very little, further differentiation occurs. A fuller account of cell division will be found in the chapter on Reproduction.

It may at this point be interesting to say something about the sporadic growth that takes place when a wound is healed. If we cut ourselves with a knife so that a gaping wound results, we soon notice certain well-defined signs and symptoms. Immediately around the wound is a redness, due to an increased flow of blood to the part owing to the tiny capillary vessels, normally either closed or but in part filled with blood, becoming fully dilated. Soon the cut surfaces are covered with a sticky substance, composed of fibrin and fluid exuded from the blood. Then multiplication of cells takes place at the sides and bottom of the wound, so that the gap gradually becomes filled with new tissue. In favourable cases, this growth ceases when the level of the adjacent skin has been reached, whilst the skin-cells round the new

tissue themselves begin to proliferate, until the wound has been completely covered. Occasionally, however, if the wound is a gaping one, and the two sides have not been approximated by stitching or otherwise, the central growth of new tissue does not stop when the skin-level has been reached, but proceeds beyond it, forming a protrusion which is commonly known as 'proud flesh.' Often this excess has to be got rid of before the skin will close over it. What has been described is the healing of a healthy or clean wound. The healing of a septic wound is not dissimilar, but there are added features. The congestion is more pronounced, and the exudation from the blood is greater—a large number of white blood corpuscles being brought to the wound to devour or otherwise kill the bacteria which are causing the trouble. As a result of the fight a collection of pus may be left on the battlefield. This fluid is a mixture of exuded lymph, liquefied tissue-cells, and dead corpuscles, with a certain number of bacteria, dead and alive. When a collection of pus is enclosed on all sides it is called an abscess, around which the healthy tissues and the blood have, more or less successfully, constructed an impervious wall, preventing the pus from escaping, and so contaminating the rest of the body. It is important, when an abscess is recognized, to make an opening into it from the outside, so as to allow the pus to escape. Otherwise it is liable to burst, or to worm its way through the defensive wall, and become distributed to other parts of the body.

The word 'tissue' has already been several times employed. Any collection of cells of the same kind, existing side by side, so as to form a mass, constitutes a tissue. Tissues of all the chief classes are found widely distributed throughout the body. Thus we have epithelial tissue, which is the kind found in the skin, the lining membranes of the mouth, stomach, and intestines, nervous tissue, muscular tissue, connective tissue, and so on. Several kinds of tissue are usually involved in the structure of what is called an organ—that is, a localized collection of tissues having special and peculiar functions, such as the brain, the heart, the liver, the spleen, and the kidneys.



THE SPINE AS AXIS

Most action round the loins

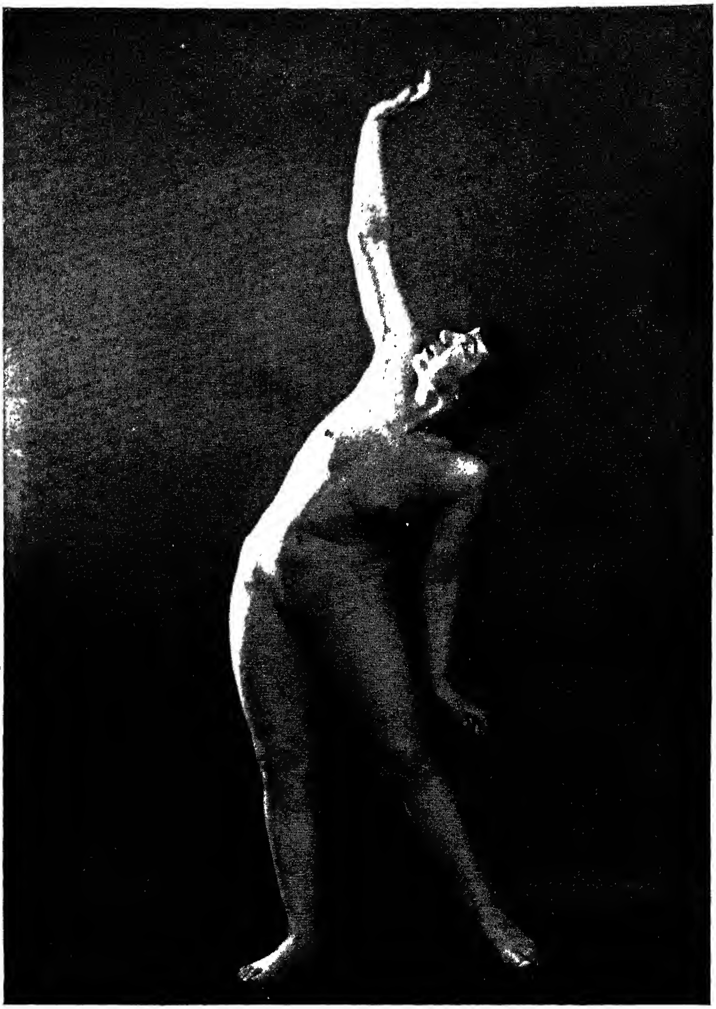


Photo by Herbert Williams

THE SPINE AS AXIS

Most action round the loins

VI—CIRCULATION AND RESPIRATION

In one minute the heart of that mythical creature, the average man, pumps out somewhere between seven to ten and a half pints of blood: that is, when he is at rest; in severe exercise anything up to six and a half gallons of blood may pass through the heart during the same time. It will thus be seen that the heart has considerable reserve power to meet emergencies.

Before the seventeenth century no one quite knew where the blood went to or what it was for. It was even thought that the arteries contained air. In 1628 the English physician, William Harvey, published his famous book proving that the blood went round in a circle—from the heart to the arteries, from the arteries to the veins, and from the veins back again to the heart. He did not know quite how the blood was carried from the arteries to the veins, for there were not in those days lenses powerful enough for him to see the capillaries; the diameter of one of these minute blood-tubes being about one two-thousandth of an inch. It was not until 1661 that the Italian physician, Malpighi, discovered these fine cylindrical vessels which connect the arteries with the veins. The circulation, then, involves the heart (the pump) and arteries, capillaries, and veins (the tubing). As this is to all intents and purposes a closed circuit, the same blood must be used over and over again.

The Anatomy of the Circulation

Certain points in the anatomy of the heart are considered in the section on diseases of this organ, and we will deal here only with those anatomical features of the heart and the circulation which are essential to an understanding of how they work.

The main function of the blood is to supply every cell of the body with oxygen, which is carried in combination with the haemoglobin in the red blood corpuscle. It will simplify matters if we follow the course of a red corpuscle which has just delivered up its oxygen to the biceps muscle of the arm. The oxygen passes from the haemoglobin into the lymph outside the capillary and thence to the muscle-fibre. Having done this, the corpuscle carries away the carbon dioxide which is one of the end-products of cell combustion. This exchange of gases takes place when the corpuscle is in the capillaries, which are so narrow that the

blood corpuscles move along them in single file. The carbon dioxide travels in the blood mainly in the form of sodium bicarbonate.

The red blood corpuscle, or, simply, red cell, then passes into a small vein, where it mixes with other red cells which also have given up their oxygen, and are bearing away carbon dioxide. (The presence of carbon dioxide gives the blood in the veins its blue colour.) The small veins run into larger veins, and the larger veins ultimately end in the two big venous trunks—the inferior and the superior venae cavae—which terminate in the upper chamber of the right side of the heart, called the right auricle. Our red cell from the arm has entered this auricle via the superior vena cava, and it passes from the auricle into the right ventricle—the lower chamber of the right side of the heart. When the right ventricle contracts the red cell travels by the pulmonary artery—the only vessel leaving this ventricle—to the lungs. The pulmonary artery divides again and again into smaller and smaller arteries, and finally into capillaries similar to those in the arm and in other parts of the body. Whilst in these lung capillaries, the red cell gives off its carbon dioxide to the air spaces of the lung, and once more takes up oxygen.

The carbon dioxide is expelled into the atmosphere when we breathe out, and fresh oxygen is taken into the lungs when we breathe in. Breathing, then, consists in supplying the red cells in the lung capillaries with oxygen, and in removing the waste product, carbon dioxide.

The red cell, now refreshed and pink, enters the small veins in the lungs, and these enter larger veins, whilst the larger veins collect into the big pulmonary veins which terminate in the left auricle—the upper chamber of the left side of the heart. From there the cell passes to the left ventricle, to be expelled when this contracts into the huge parent artery of all the arteries in the body—the aorta. The red cell once more carries on its duty of supplying the oxygen it has picked up in the lungs, maybe to the arm, or maybe to the big toe; once it has delivered its oxygen it takes away carbon dioxide and returns again via the veins to the right auricle and so back to the lungs.

The red corpuscle, it will be observed, travels through two circuits: a short circuit from the right side of the heart, through the lungs, to the left side of the heart; and a wide circuit from the left side of the heart, through the aorta, and many other arteries, to any part of the body, to end its journey finally in the right side of the heart.

There are two important divisions in this wider circuit. The venous blood that leaves the intestines is collected into a single vein which enters the liver, where it splits up into capillaries. These capillaries come into intimate contact with the liver cells, and deliver to them the foodstuffs collected from the intestines. The capillaries once more merge into veins, which leave the liver to enter the inferior vena cava.

The liver, then, intercepts the venous blood from the intestines on its way to the heart. The second important division is the circulation of blood through the kidney. The kidney is an extremely vascular organ, and it filters off from the blood passing through it excess water and salts and various poisonous products formed in the natural course of the body's working.

A red corpuscle lives for about thirty to forty days, and during this time it never stops working; when it dies it is replaced by another, manufactured in the bone marrow.

THE HEART.

When it is realized that the heart has to go on pumping out blood day and night, year in year out, and has to be ready to meet such emergencies as running for a bus or catching the last train home, in addition to supplying the constant needs of the body, it is evident that such a mechanism has to be very accurately adjusted, and at the same time relatively 'fool-proof' for any blood corpuscle that feels inclined to take the wrong turning.

The heart is a muscular bag, and the muscle-fibres are so arranged that when they contract the blood in this bag is, so to speak, squeezed out through the various openings in it. The bag itself is, as we have seen, divided off into four compartments by two partitions—one longitudinal and one horizontal. The openings into these compartments are guarded by valves, so that each can be shut off, when necessary, from its adjacent compartment. The right side of the heart is completely shut off from the left side by the longitudinal partition. The heart is itself supplied with blood from arteries (the coronary arteries) which come off at the origin of the aorta.

THE HEART-BEAT.

The heart beats, on an average, seventy-two times a minute. The contraction of the auricles lasts about one-tenth of a second, and that of the ventricles three-tenths of a second; the period of relaxation is about four-tenths; so the whole sequence of changes between the beginning of one beat and that of the next lasts about eight-tenths of a second. Although the right and the left side of the heart are separated from each other, the former containing impure blood loaded with carbon dioxide and the latter bright blood carrying oxygen, it must not be thought that during contraction of the heart the right side contracts first and the left follows after. What actually happens during the beat or contraction of the heart is that the two auricles (right and left) contract together, and then, after a slight pause, the two ventricles.

It will be simpler if we consider what happens on one side only—say the left. In the interval following one heart-beat the muscle

relaxes, gathering strength for the next. During this period blood which has exchanged its carbon dioxide for oxygen in the lungs is entering the left auricle from the pulmonary veins. Some of it flows through the opening between the auricle and the ventricle into the

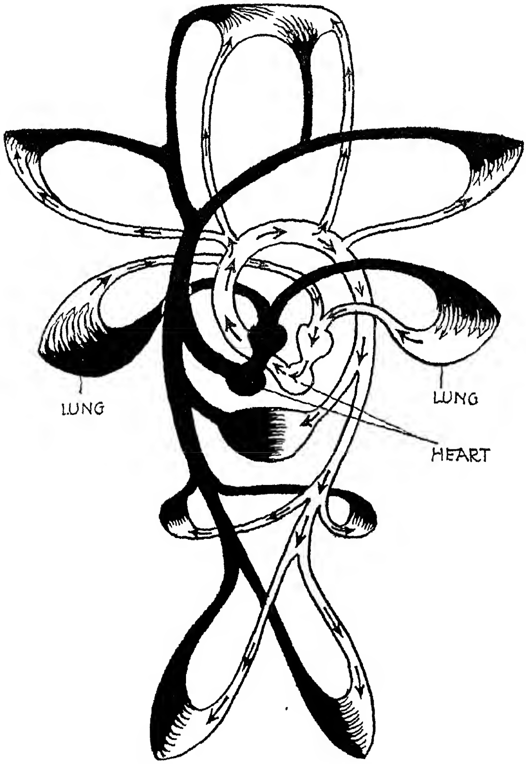


DIAGRAM OF THE CIRCULATION OF THE BLOOD
Black = Venous Blood
White = Arterial Blood

latter chamber, the muscular wall of which is relaxed. The auricle then contracts and expels the rest of the blood it contains into the ventricle. The ventricle now begins to contract, and the rising pressure within it forces into close contact the valve flaps which separate it from the auricle. For a short time it remains a closed chamber, until finally the pressure rises high enough to force open the valves which guard the opening of the ventricle into the aorta. The blood then shoots from the ventricle into this huge artery, and the increased

pressure in the latter which results from accommodating this increased quantity of blood shuts down once more the aortic valves.

These alterations in blood-volume and blood-pressure in the chambers of the heart and in the aorta, with the consequent opening and closing of valves, ensure that the blood goes in the right direction, and that there is no back-flow. If the valves are diseased, and so cannot close properly, leakage occurs, and the efficiency of the heart-pump is impaired. If the heart-muscle itself is damaged the driving force of the pump is diminished, and a more serious deficiency arises.

The above description applies to the cycle of events on the left side of the heart. A similar sequence is followed on the right. That is to say, when the left ventricle contracts and sends out its oxygenated blood into the aorta, the right ventricle contracts simultaneously and propels the carbon dioxide containing blood it has received from the veins of the body via the right auricle into the pulmonary artery, and so to the lungs to be purified. As the circulation of blood through the lungs is a much smaller affair than the circulation of blood through the whole of the body, the muscle of the right ventricle is about one-third the thickness of that of the left, because it has much less work to do.

HEART SOUNDS.

When the heart-muscle contracts it makes a noise, and this noise can be heard through the stethoscope as the first sound of the heart. This is followed by a second sound due to the closure of the aortic and pulmonary valves. These close when the pressures in the aorta and in the pulmonary artery are greater than the pressures in the left and right ventricles respectively, and indicate that the contraction of the heart is at an end, and the period of relaxation of the heart-muscle has begun. Alterations in the quality of these sounds occur in heart disease and inform the physician of what has gone wrong.

BLOOD-PRESSURE.

The aorta, we have seen, is the large artery that leaves the left ventricle. It soon divides into various branches which go to the arms, the head, and the neck. It then descends through the chest and enters the abdomen, where it gives off branches to the intestines and abdominal organs, and finally divides into the arteries that supply the legs with blood. The aorta branches out like a tree. The area covered by the branches is much wider than the area taken up by the main trunk, so that as the blood flows through this wider area the stream slows up and the pressure within the successive branches progressively lessens. (For example, the blood flows at the rate of about one foot a second in the aorta, and one inch a minute in the capillaries.) There is thus a steady fall of pressure from the heart to the smallest arteries.

When the heart beats and throws out a certain volume of blood into the aorta there is a rise of pressure in the arteries. When the heart rests in between the beats there is a fall of pressure. In order that the blood-flow may be steadily maintained all the time, the arteries have muscular and elastic tissue in their walls. During the contraction of the heart the increased blood-volume in the arteries is accommodated by the distension of the arterial walls, and the elastic recoil of these vessels after the contraction has ceased serves to maintain the pressure within them, and to ensure the continuity of the blood-flow; otherwise the blood would be pumped through the circulation in a series of intermittent spurts, and the cells of the body would be alternately exhausted and refreshed instead of having a constant supply of essential oxygen. The blood-pressure in a medium-sized artery, such as that in the upper part of the arm, is, during contraction (or systole) of the heart, equivalent to that required to raise a column of mercury about one hundred and twenty-five millimetres and, during relaxation (or diastole), about seventy-five millimetres.

THE CAPILLARIES AND THE VEINS.

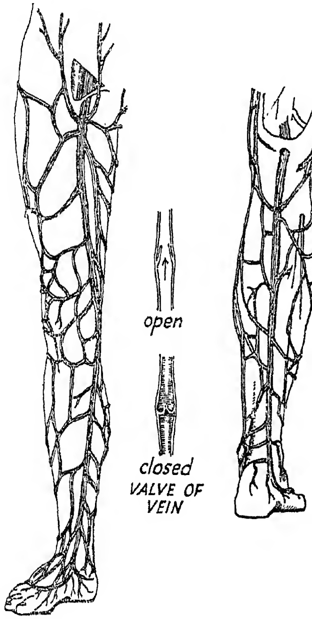
The capillaries are in direct continuity with the smallest arteries. A close network of these minute vessels permeates every tissue of the body; one square millimetre of muscle, for example, is penetrated by well over a thousand of these thin tubes, which have no muscular or elastic tissue like the thick-walled arteries, but are just one cell in thickness. In the capillaries the blood-stream widens out into millions of rivulets which feed every cell in the body with oxygen and food-stuffs. Not all these channels are open at the same time. If they were they would mop up the blood in the body as a sponge does water, the circulation could not be maintained, and death might ensue. It has been suggested that this is what actually does occur in the shock that follows severe injuries.

What happens is that the capillaries open and close according to the needs of particular tissues at particular times. For example, during muscular exercise there is a marked dilatation (widening) of the capillaries in the muscles; at the same time there is a narrowing and shutting down of the capillaries in the stomach and the intestines. In this way the blood is, so to speak, shunted off from the digestive system to the part where it is needed—the muscles.

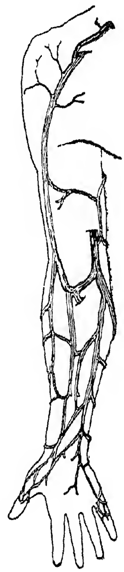
The head of pressure in the arteries maintains the flow of blood through the capillaries, and by the time the capillaries have joined up with the veins the blood-pressure has fallen considerably. The blood-pressure in the veins continues to fall until the great veins enter the heart, and as the blood in a vein in the big toe has to travel about three-quarters of the length of the body to reach the heart there

must be some mechanism other than the arterial pressure to bring this about.

One of the most important factors in securing the return of blood in the veins to the heart is the suction action exerted by the movements of the chest, in breathing, on the greater veins (superior and inferior



VEINS OF THE LEG



VEINS OF THE ARM
Front view

venae cavae) within this cavity. Normally the pressure within the chest is negative. That is to say, if a hole were made in the chest wall the air from outside would rush in. When we breathe in, this negative pressure in the chest is increased and so sucks in blood from the veins outside it, for the veins are thin-walled and collapsible tubes, and do not have the thick, muscular, elastic walls of the arteries. During in-breathing (or inspiration) the diaphragm descends into the abdomen and increases the pressure within it, thus driving venous blood up into the chest towards the heart. The blood in the veins is prevented from going in the wrong direction (say back again towards the feet) by the presence of valves at intervals along their course.

Another factor in the propulsion of blood along the veins is the contraction of the muscles. During exercise this is particularly obvious.

WHAT MAKES THE HEART BEAT.

It used to be thought that nerves made the heart beat. But a frog's heart can be removed from a frog that has just been killed and it will go on beating for hours if it is kept at the right temperature, and in a suitable solution of salts. This and other evidence goes to show that the cause of the heart-beat is in the heart itself. It has been found that this automatic power of beating possessed by the heart-muscle is most marked in the region where the great veins enter the heart: the auricles, left to themselves, have a much quicker rhythm than the ventricles left to themselves; and they are much more irritable. This increased excitability and rhythmicity at the venous end of the heart determines the sequence of events in its contraction—auricles first, ventricles second—and so the blood goes in the right direction.

Not only do these properties exist in the heart-muscle, but the impulse to contraction is conducted from one chamber of the heart to the next by a special modification of the muscle. This is a different state of affairs from that which exists in, say, the biceps muscle: here the impulse to contraction passes down a nerve, and if the nerve is cut the muscle is paralysed. The heart, so to speak, regulates its own affairs as far as possible.

NERVOUS CONTROL OF THE HEART.

Nevertheless, the nervous system—the master system of the body—has an important part to play in co-ordinating the activity of the heart with the activity of the body, and supplies it with two sets of nerves: one set tending to slow the heart down (branches of the vagus nerve), and the other to quicken it (branches of the sympathetic nervous system). The sympathetic and the vagus nerves are not under conscious control. You cannot decide to quicken your heart as you can to quicken the movements of your leg muscles. Such individual freedom would be dangerous to so important an organ.

We know that if we get a sudden fright the heart starts to beat quickly—an effective preparation for flight from danger, for in flight more blood must be sent round the body and at a quicker rate, so as to supply the harder working muscles with oxygen. In broad terms, it seems that the sympathetic nervous system comes into action, quickening the heart and strengthening its action in times of emergency (running away, exercise, fighting), and that the vagus puts the brake on during rest so as to prevent it from overdoing things. These nervous activities are regulated by nerve-centres in the brain-stem, and from these centres impulses also go out along nerves which supply the blood-vessels, governing their state of contraction, and so regulating the blood-pressure according to the needs of the body. The nerve-centres in the brain are sensitive to chemical changes in the blood. An excess of carbon dioxide will stimulate the brain to send impulses along the

sympathetic nerve, and so quicken the rate of the heart. As an excess of carbon dioxide is produced during exercise this mechanism ensures automatically that the active muscles will receive more blood. At the same time the action of carbon dioxide on the brain results in an increase in the rate and depth of breathing, and this at the same time gets rid of the excess carbon dioxide, and brings a greater quantity of oxygen into contact with the capillaries in the lung. This delicate nervous and chemical control of the heart (and of the lungs) is so adjusted as to subserve the needs of the muscles of the body.

Respiration

Breathing is another bodily activity which is carried on automatically and, for the most part, unconsciously. As the muscles which control breathing are under voluntary control you can, of course, breathe quickly or slowly, or hold your breath, or blow things away from you. But you cannot do these things consciously for any length of time, nor can you control your rate of breathing, say, at the end of a hundred-yards race.

Essentially breathing—or respiration—means the exchange of the gases carbon dioxide and oxygen in all the tissues of the body. We have already seen that the blood from the veins gives up the carbon dioxide —one of the final products of bodily activity—to the air spaces of the lungs, and that the blood in the pulmonary capillaries takes up oxygen at the same time. The oxygen-carrying blood in the capillaries of a muscle delivers up its oxygen to the muscle-fibres, and carries away the carbon dioxide, so that respiration consists of two processes: the transport of the carbon dioxide from all the tissues of the body to the lungs, and so to the outside air; and the transport of oxygen from the air in the lungs to all the muscles and the organs of the body. The transport system is made up of the heart and the blood-vessels. These two systems, the respiratory and the circulatory, co-operate in the bringing of every cell in the body into contact with the air.

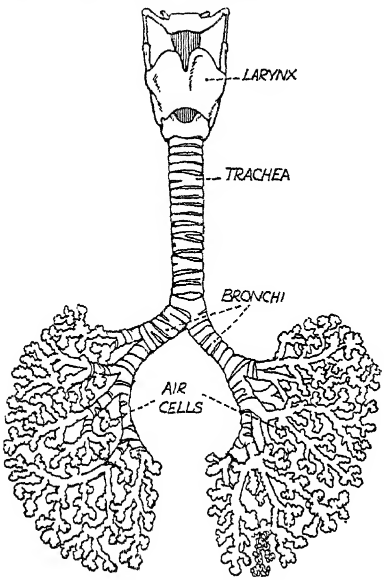
In order to make this possible Nature has evolved those enormous spongy masses, the lungs, which are honeycombed with little air pockets, each pocket being enveloped in a closely-woven network of capillaries. In this way an extensive layer of blood is brought into contact with a large volume of air. Between the blood in the capillaries and the air in the lungs only the thin walls of the capillaries and the thin walls of the air pockets are interposed.

THE ANATOMY OF RESPIRATION.

Broadly stated, the problem of respiration seems simple. But the human body is such an elaborate machine, and it has to work efficiently under such varied conditions, that different chemical and nervous

'tricks' have been evolved to safeguard the mechanism from being thrown suddenly out of gear.

Before considering these tricks we must look into the structure or anatomy of the air passages. Some account of this will be found in the section dealing with disease of the lungs. Briefly, the entrance to the air passage at the back of the throat is guarded by a thick valve-like structure, the epiglottis, which prevents food from going the wrong way. Below this is the larynx or voice-box or Adam's apple, which is simply a wind instrument for the production of sound. Below the larynx the trachea, or windpipe, strengthened with rings of cartilage (gristle), descends into the cavity of the chest to divide into the main bronchial tubes to the right and left lungs. These tubes (bronchi) divide and subdivide, like the branches of a tree, finally opening out into the air sacs or alveoli where the interchange of carbon dioxide and oxygen takes place. These alveoli are like thick clusters of grapes at the end of each small bronchus or bronchiole. Each alveolus is about half a millimetre in diameter, and is lined with large flat cells. Spread over its surface is a thick mesh of pulmonary capillaries.



THE AIR PASSAGES

The lungs are covered with a membrane, the pleura, which also lines the inside of the chest wall; and a thin layer of fluid secreted between these two layers of pleura enables the lungs to move easily within the chest during respiration. Separating the lungs from the abdomen is a strong muscular sheet, the diaphragm, which plays an important part in respiration. The ribs and the muscles attached to them are so arranged that during inspiration (breathing in) the chest can expand forwards and upwards and sideways. The diaphragm during inspiration descends into the abdomen, and so increases the vertical diameter of the chest cavity. In this way the chest acts as a bellows, and draws air into the lungs. Expiration (or breathing out) is mainly a passive recoil, for the elastic lungs tend to contract round their roots. By consciously drawing in your abdomen you can, however, forcibly expel air—as in coughing and sneezing.

The amount of air passing in and out of the lungs in normal quiet breathing is about five hundred cubic centimetres or thirty cubic inches. By taking a very deep breath about another hundred cubic inches can be taken into the lungs; and after a normal expiration about another hundred cubic inches of air can be forcibly expelled.

THE REGULATION OF RESPIRATION.

Respiration is carried on automatically day and night, year in, year out. This is an obvious but remarkable fact, looked at from the point of view of an engineer. Although voluntary muscles—muscles, that is, over which you have conscious control—perform the act, yet the automatism is involuntary; and it seems that this perpetual concertina movement of the chest is governed by groups of nerve-cells (nerve-centres) in the stem of the brain. These nerve-centres receive messages from various sources, and send out their instructions accordingly. There is a constant stream of messages going from the lungs up the vagus nerve during each act of breathing. This nerve, so to speak, informs the brain just what the lungs are doing, so that inspiration and expiration can be evenly balanced. It would not do if, for example, you continually took a short breath in and then a long breath out. Then, too, these nerve-centres respond to emotional stimuli: 'I was breathless with excitement,' you hear people say.

As the main function of respiration is to supply the body with oxygen and to get rid of carbon dioxide, we find that these brain-centres are very sensitive to abnormal quantities of these gases in the blood. An excess of carbon dioxide in the blood stimulates the nerve-centres in the brain to send out urgent messages along the nerves supplying the muscles which govern respiration, and breathing is quickened and deepened. This has the effect of getting rid of more carbon dioxide from the lungs and, of course, of bringing more oxygen into them. Now excess of carbon dioxide is produced when any extra exertion of the body is made, as in violent exercises; and this extra exertion requires more oxygen to complete the processes of combustion which provide the surplus energy required. So we see that this remarkable co-ordination between muscle, brain, lungs, and heart is to a large extent effected by the action of carbon dioxide on the nerve-centres. Thus the body utilizes this waste product to hasten the mechanism whereby not only the waste is itself expelled, but also more blood, and so more oxygen and food is brought to the service of the active tissues. It is an excellent example of the economy of co-operative effort.

This power of carbon dioxide to stimulate respiration is now being exploited by physicians in the resuscitation of infants suffering from asphyxia and patients who have been under an anaesthetic.

VII—METABOLISM AND FOOD UTILIZATION

In the broadest sense metabolism may be defined as the sum total of all the chemical processes which go on in the body. These chemical reactions have as their most obvious results the production of heat and movement, and it has therefore been the popular practice to compare the body to a sort of engine. This comparison, however, gives but a superficial picture of what is actually occurring in the body, as it takes no account of the facts that the body has to create suitable fuel from the food it absorbs and that it can use this for self-repair as well as for heat production. An engine, on the other hand, is supplied with fuel ready to be changed into energy, and has no power of automatic repair. Again, the fuel supplied to the animal organism can be transformed into forms of energy, for example, mental and reproductive energy, of which we have no counterpart in the inanimate world.

It used to be the practice to distinguish chemical from nervous action, but analysis of the phenomena presented has shown that even such apparently non-chemical activities as the nervous regulation of the heart-rate, or the contraction and dilatation of the pupil of the eye, are really effects produced by chemical agents formed in the body. It appears that all our bodily mechanisms are dependent for their proper functioning on the production of appropriate chemical substances, which act as stimuli or controllers; and on a proper condition of irritability of the organ which carries out the final act of the mechanism.

In the lower organisms, not provided with complex nervous systems, such a chemical regulation has long been recognized, but it is only in recent times that it has been realized that similar regulation occurs in the infinitely more highly organized and specialized higher animals. Let us take an example. The rate and force of the heart are among the most important phenomena in the body, for the proper supply of blood and therefore of oxygen to the muscles, brain, glands, etc., is thereby determined. Now the rate and force of the heart's contractions are normally under the control of certain nerves: one group, the vagus nerves, comes to the heart from the lower part of the brain, the medulla, and exerts a slowing action on the heart; another group, the sympathetic nerves, comes to the heart from the spinal cord, and exerts a hastening action on it. Stimulation of these groups of nerves can be carried out experimentally by various means; and when this is done to the vagus nerves the heart either slows or stops. It is an interesting fact that if

the blood coming from the heart after the vagus nerves have been stimulated is allowed to pass into another and normally beating heart it is found to possess the property of slowing or stopping the action of that heart. In fact, stimulation of the vagus nerves produces a substance which in its turn can stop or slow another heart. This substance, which has been identified as a complex chemical compound, called acetyl-choline, has resulted directly from the stimulation of a nerve; and it is found that injection of artificially manufactured acetyl-choline into an animal produces the same effects on the heart as is caused by stimulation of its vagus nerves. The production of this substance goes on in the body normally, and is an example of what is included under the head of metabolism.

The special substances required for the control of metabolic processes in the body are in some cases produced by the activities of definite glands. Such a gland is the adrenal or suprarenal gland. And a short consideration of one series of events initiated by this gland will be instructive.

For metabolism to take place sugar must be present in the blood. This sugar is glucose, and will be dealt with in greater detail later. The amount of sugar in the blood varies during the day, but we may, at this stage, take as a roughly accurate figure a hundred milligrams per hundred cubic centimetres whole blood. If we take five litres as the total amount of blood in an average normal adult, the total glucose in the blood is about five grams. This level of blood sugar, as it is called, is maintained by the co-operation of several factors, but that of most importance in the present connection is a group of specialized brain-cells called the pons. Now it is known that emotional excitement increases the amount of sugar in the blood, in some cases doubling it. Analysis of this phenomenon has been going on for many years; and the sequence of events is now more or less understood. We are unable to present any physical picture of what constitutes the initial stimulus in the brain which sets in train the psychological condition known as emotion; but some form of energy is certainly liberated. Granted that such a state of energy liberation is initiated, impulses are transmitted from the higher centres in the frontal part of the brain which by various routes reach the cells in the pons just referred to. These cells having been stimulated, impulses pass down the spinal cord along special tracts, and emerge in the two nerves known as the splanchnic nerves, which partly control the activities of the liver, and probably completely control those of the adrenal glands. Part of the result is a stimulation of the adrenal glands, and as a consequence these organs secrete a substance called adrenaline into the blood. This substance possesses very active properties, among which is that of stimulating the cells of the liver to break down a complex substance, glycogen,

which is present in considerable quantities in the liver in normal circumstances. The breakdown or katabolism of glycogen gives rise to glucose, which passes into the blood, and thus raises the blood sugar. We thus have the following sequence of events:

Emotional excitement in higher centres.
↓
Stimulation of brain cells in pons.
↓
Passage of impulses down to adrenal glands.
↓
Liberation of chemical activator adrenaline.
↓
Stimulation of liver activity by adrenaline.
↓
Breakdown of liver glycogen to glucose.
↓
Rise in blood sugar.

This is a very much simplified picture of what actually occurs, but it will serve to indicate the importance of chemical activators of metabolic processes. Many such chemical activators are dealt with more fully in the chapter on the endocrine system.

The word 'metabolism' is often used in the more restricted sense of the sum total of the chemical changes which the food-stuffs undergo, i.e. intermediate metabolism, and of the energy which is obtained from each particular food-constituent. We speak of the metabolism of sugar (carbohydrate), of fat, of protein, and of mineral salts, when we wish to refer to the intermediate or ultimate fates of these substances, after they have been digested and absorbed. Digestion is an integral part of metabolism in ordinary normal life, but metabolism may take place without any digestive processes occurring in the intestine. Consider, for example, the case of a starving man after the first twenty-four or thirty-six hours of his fast. At this time the organism is receiving no food from the gastro-intestinal tract, but analysis shows that the blood contains all the substances which are present during normal life; that the urine contains those end-products which are the end-products of the utilization of protein and fat; and that the air breathed out contains the gas, carbon dioxide, which we know arises from the burning or metabolism of carbon. Metabolism, then, goes on during starvation. Such metabolism is called *endogenous metabolism*, to indicate that it proceeds at the expense of substances which are constituent parts of the organism itself, and to distinguish it from *exogenous metabolism* which proceeds at the expense of matter taken into the intestine.

Another example of the fact that metabolism does not necessarily involve digestion is given by an organism kept alive for long periods by the injection of nutrient matter directly into the circulation. This is, of course, an instance of exogenous metabolism. In such a case great care must be taken as to the nature of the matter injected. The familiar example of the life of the child before birth will at once suggest itself as an instance of metabolism proceeding without food entering the intestine, and sustained by products passing from the circulation of the mother into the circulation of the child.

What do the complex reactions of metabolism bring about? Normal metabolism makes food available for energy requirements, for growth, for the replacement of wear and tear of tissues, for reproduction and for the synthesis of vital internal secretions. A simple example or two will be useful. Milk, frequently called the perfect food, contains fat, protein, and carbohydrate; but, before these substances can be used by our bodies to produce heat or to produce new muscle or fat, a series of complex changes has to be gone through, so that the original milk loses its identity completely. In using milk for energy purpose, i.e. for the production of body heat, the organism does not burn milk, because the muscles, in which most of our heat is formed, cannot use so complex a substance. The organs, particularly the liver, have to deal with the constituents of the milk so as to prepare products with which the muscles can deal. Again, consider a person who eats too much, and over a period of years has gradually grown fat. Such a person is generally found to eat too much starchy or sugary food, or too much fatty food, or both. The transformation of starch or animal fat to human fat is no simple matter, and involves a very complicated chain of chemical reactions.

It is clear that metabolism will be different according to the conditions under which the organism exists. Thus, in the starving subject the processes of endogenous metabolism will represent a total loss to his body, and he will lose weight. In a growing child, on the other hand, the intake of food material must be such that his energy requirements are met, and that enough is left over for the formation of new tissue. In the normal adult the intake of food and the metabolic response thereto are usually just sufficient to balance the wear and tear incident to everyday life, and the weight remains more or less steady. The fact that normal adults keep their weight almost constant, in spite of considerable variation in the daily food intake, is one of the puzzles physiologists have not yet solved. It appears that, just as the heart can in time of necessity respond by doing more work, so metabolic processes can, if occasion arises, deal with more food material, and so keep the body-weight constant. How this is done, however, we do not know.

The study of metabolism has a quantitative as well as a qualitative side. We are able to measure the amount of energy produced in the body from the various constituents of the food taken, as well as to trace what the ultimate fates of these substances are.

Metabolic processes are divided into those which result in the building up of new body material and those which result in the breakdown of substances for energy purposes. The former are called anabolic changes, or anabolism; the latter are called katabolic changes or katabolism. An example of these types of metabolism will be useful. Sugar, when absorbed into the system may, according to circumstances, be completely broken down and burnt (oxidized) for the production of heat, or it may be built up to fat after first being split into simpler compounds. We therefore speak of the katabolism of sugar for energy purposes and the anabolism of sugar to fat. Such processes are going on side by side all the time, and it is the equilibrium between these processes which determines the state of nutrition of the body as a whole and whether or not growth is taking place.

We must now proceed to consider the nature of the substances which are metabolized by the organism.

Water

One often loses sight of the fact that about 75% of the body is composed of water. All the reactions between substances occurring in the body take place in a watery medium, and the proper adjustment of water content in the tissues is an essential condition of normal physical life. Water is constantly being lost by evaporation from the sweat glands in the skin, by being carried out with the expired air, and by the secretion of urine. These processes would soon produce a great diminution in the water content of the body if fluid were not absorbed to replace the loss. Life is possible only if the protoplasm of the cells maintain a certain water content, and cannot continue for any length of time without renewed supply. Thirst is a much more serious matter than hunger, for, whereas more or less normal metabolism may continue for many days without solid food, it cannot without water. The period during which life can continue entirely without water varies with individuals and with external conditions. It must be remembered that all food-stuffs contain water, and also that in the metabolism of food for energy purposes water is produced. For example, if we were to eat a pound of absolutely dry starch, the body in disposing of it would produce rather more than half a pound of water, so that though the starch was quite dry it could not be said that the body was deprived of water. Similar results are obtained with absolutely dry fat or protein, as is seen in the following table.

Water produced from the metabolism of absolutely dry food

1 lb. starch	produces	rather	more	than	$\frac{1}{2}$ lb.	water.
1 lb. protein	"	"	"	"	$\frac{2}{5}$ lb.	"
1 lb. fat	"	"	"	"	$1\frac{1}{5}$ lb.	"

To find out, therefore, how long a man may live without water it is also necessary for him to go without food. It is recorded that a certain Viterbi, a political prisoner, went on hunger strike, taking neither food nor drink, and survived for eighteen days. In tropical conditions this would have been impossible; death would have occurred in two or three days unless, as was done by a Mexican lost in the desert, the urine were drunk. During starvation the breakdown of the body's own material involves the liberation of a considerable amount of water, but this is insufficient to supply the necessary quota. Animals seem in general better able than man to withstand water deprivation.

Some idea of the amount of water lost by the lungs in the expired air and from the skin by perspiration is obtained when we consider that a man at rest in an atmosphere of medium humidity and at 23° C. loses some six hundred and eighty grams of water per day in these ways alone. This loss of water occurs mainly from the arms and legs, which account for some three-fourths of the total. It must be realized that the loss of water from the skin may not manifest itself as visible perspiration, but as what is called insensible perspiration. The rate of loss of water from the surface of the body being dependent upon the temperature and humidity of the surrounding air, it is clear that the demands of the organism for water will vary with the weather. The water which is lost in this way is carried to the skin in the blood, which contains about 80% water. Thus it follows that the more freely the blood enters the peripheral tissues the more readily will the processes of surface evaporation take place. In hot weather the peripheral small blood-vessels dilate and, if the surrounding air is relatively dry, large amounts of liquid are removed by evaporation and perspiration; but if the environment is moist very little liquid may be lost in this way. In cold, dry, calm conditions the surface blood-vessels contract and so less liquid reaches the skin in a given time, with a consequent diminished peripheral loss. In cold, dry, but windy weather the peripheral loss may be greatly increased as a result of the rapid removal of such water vapour as is formed. The consequently excessively dry layer of air near the skin stimulates the secretion of more perspiration, which is again rapidly removed. The change of the sweat from the liquid to the gaseous state takes heat from the body and from its immediate environment. The feeling of coolness we experience when exposed to a breeze even of warm air is due to the stimulus given to further evaporation from the body by the removal of perspired liquid or vapour.

The loss of body heat through the evaporation of water from the skin is one of the ways whereby warm-blooded animals keep the temperature of their bodies constant within narrow limits. The loss of water by the skin is also of great importance in helping to remove toxic substances from the organism, and the common practice of stimulating this process by drugs during a febrile disease is an application of this fact, although the main reason for inducing perspiration is to increase the loss of heat and thus lower the blood's temperature.

The principal route by which water is lost from the body in ordinary circumstances is, however, the kidneys. These organs are specially designed to remove from the body the end-products of metabolism. The urine is a very complex fluid which normally holds the waste products in solution in water; but it is a mistake to regard it as a simple solution of the same sort as a solution of salt in water. This is easily shown, for if clear urine be taken and its water removed by distillation at low temperatures, the residue of solid matter cannot be re-dissolved simply by pouring the distilled water back again. The conditions for solution in urine are provided by the body itself, and we are not yet clear as to the precise nature of these conditions. The secretion of urine is dealt with in another section, but it is relevant to point out here that the amount of fluid removed in the urine is greatly influenced by the activity with which fluid is being lost by the lungs and by the skin. Thus, when large amounts of fluid are being lost from the surface of the body the volume of urine may diminish very greatly; whereas, in cold weather, when much less loss takes place from the skin, more urine is secreted. The peripheral blood-vessels are contracted in cold conditions, and hence more blood is available for supplying the internal organs. An increased supply of blood to the kidneys induces a greater secretion of urine.

The following table gives an idea of the average daily amounts of water taken in by, and lost from, the body in normal circumstances.

Average total water exchange

Intake	c.c.	Output	c.c.
As beverages	1,450	In urine	1,500
In food	800	From the skin	600
Resulting from burning of food	350	From the lungs	400
		In the stools	100
	2,600		2,600

Such a perfect balance is only possible when the functions of the kidney and the heart are being normally carried out. In the event of defective function in these organs water cannot be excreted properly;

and, as a result, we get the condition of oedema, or dropsy, water accumulating in various parts of the body. The retention of water in the tissues leads to all sorts of disturbances in the muscles and elsewhere, particularly if there is a deficiency of salt as well. Miners, working in very confined spaces, perspire very freely, and tend to drink large quantities of water. But sweat consists of salt as well as water, and so the loss of large amounts of sweat involves a great loss of salt also, which latter is not replaced by simply drinking water. The result is that the muscles after a time become deficient in salt and too rich in water; a condition provoking contraction or cramp, known as miner's cramp. The cure is simple: if salt (10 grains to the gallon of water) is added to the drinking water, the symptoms disappear.

Salts

By a salt we mean a substance which results from the interaction of an acid and a base. A salt, therefore, consists of two parts or radicles, an acid radicle and a basic radicle. Examples of salts of importance in biology are, sodium chloride, calcium phosphate, sodium bicarbonate, potassium chloride, potassium iodide.

It is hardly necessary to remind the reader that ordinary common salt, or sodium chloride, is essential to life. The relatively small amount of this substance in both animal and vegetable foods, further diminished by the loss which occurs in cooking, is appreciated by the body, and a desire for salt as a supplement to our meals is commonly experienced. But ordinary table salt is far from being the only salt in the body; and, although the want of the other salts is not so acutely felt as is that of common salt, their absence soon makes itself felt by disturbances in metabolism.

Metabolic processes are carried out by the activity of millions of cells; which structurally and functionally must be kept in a highly efficient state. The integrity of the body cells depends in large measure on the salt content of the fluids in which all the tissues are bathed. We have seen that the peculiar condition known as miner's cramp is due to a deficiency of salt in the tissue fluids. Another striking example of salt imbalance is the condition known as tetany. This disorder, which must not be confused with tetanus, may be brought about in a variety of ways. Its most characteristic feature is a striking hyperexcitability of the muscles, so that a stimulus ordinarily insufficient to produce a contraction will, if tetany is present, lead to violent spasms of the muscular system. It is found that in every case of tetany there is a deficiency of calcium salts in the blood and the tissues, and that the simple administration of calcium salts will often go far towards remedying the symptoms. It may, therefore, be concluded that the presence of a

sufficiency of calcium salts prevents an increased excitability of the muscles; proper muscle function is only possible if the body fluids contain a properly balanced mixture of salts.

In recent years much has been heard of the necessity of maintaining a supply of iodine in the body in order to prevent the appearance of certain forms of goitre or enlargement of the thyroid gland in the neck. In those countries where insufficient iodine is present in the food the necessary iodine is often given in the form of the salt potassium iodide.

The importance of an adequate ration of calcium and phosphorus salts in the diet of growing children in order to ensure the proper formation of bone cannot be over-stressed. Again, in order that the body may form haemoglobin, the red colouring matter of blood, it requires iron, and hence we use preparations of iron in the treatment of those forms of anaemia brought about by a deficiency of haemoglobin in the red cells. The necessity of iron salts is strikingly shown in the case of infants who have been kept for too long a time on a diet of milk, which is poor in iron. The infants develop an anaemia which is rapidly cured by giving them medicines containing iron salts.

It is well known that certain organs have been removed from the body and kept in a state of activity for a considerable time by driving an artificial 'blood-stream' through the arteries. By means of this procedure, which is called perfusion, we have been able to study certain properties of these organs hitherto unsuspected. Apart from many mechanical difficulties in this type of experiment, it is essential to use a perfusing fluid with a carefully adjusted composition. Oxygen also must be supplied in adequate proportions. The salts which have been found essential in order that the best functional results be obtained are: sodium chloride, potassium chloride, calcium chloride, sodium bicarbonate, sodium phosphate, magnesium chloride, and to these salts must be added the sugar glucose.

This short consideration may be sufficient to indicate that, although salts are not themselves energy producers, the power which the body cells possess to utilize food-stuffs depends upon these cells being bathed in a fluid which contains various salts in adequate amount, and in proper proportions. In other words, proper metabolism is only possible in a specially adapted medium.

Proteins

Proteins are complex chemical compounds, present in all living matter. They are composed of the elements carbon, hydrogen, nitrogen, oxygen, sulphur, and in some cases phosphorus. These elements exist in the protein in the form of relatively simple combinations called *amino-acids*, of which about twenty are known. These amino-acids

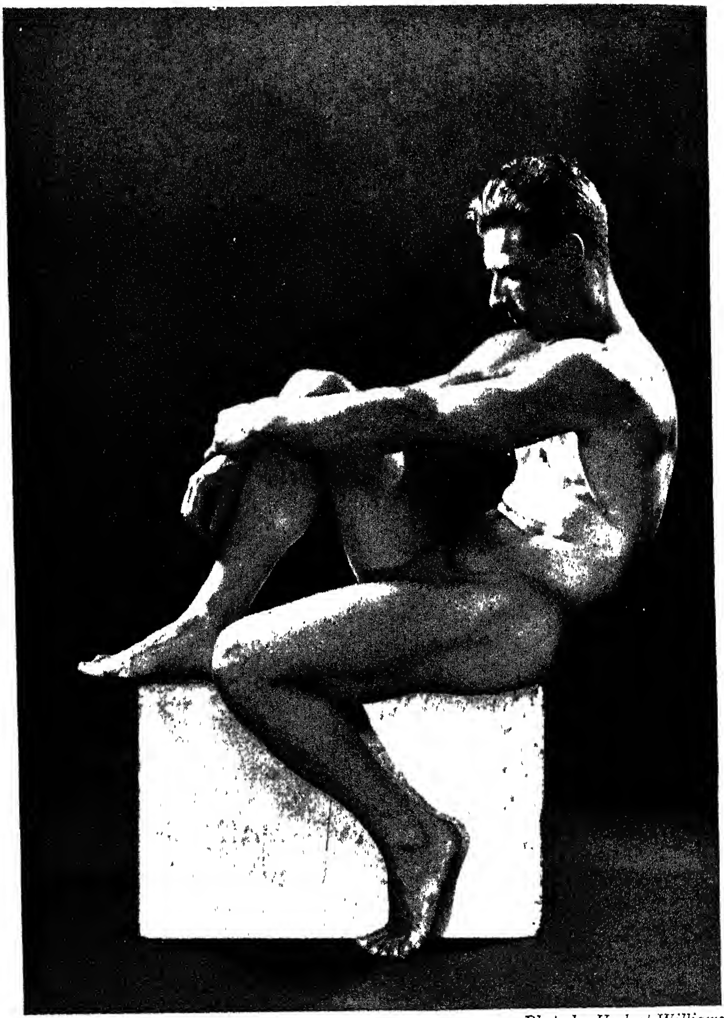
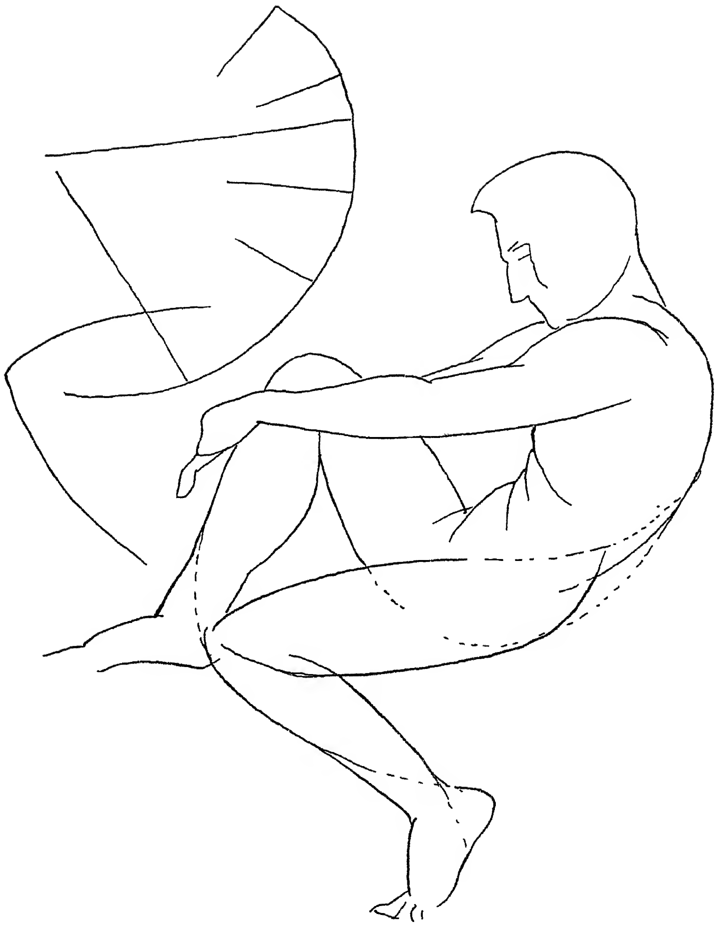


Photo by Herbert Williams

THE SPINE AS AXIS

Rhythmic movement of masses, governed by the curve of the spine. Here a convex curve



THE SPINE AS AXIS

Convex curve

are special combinations of organic acids and ammonia. Thus, acetic acid can in proper circumstances be made to react with ammonia to form amino-acetic acid, which is also called glycine, and occurs in the protein gelatine. Whilst the properties of these amino-acids are known fairly thoroughly, those of the proteins, which are chains of amino-acids linked together in a special way, are much more obscure.

Amino-acids are very often identifiable by tests more or less complicated and dependent on the reactivity of particular groups in the amino-acid molecule. There are, for example, three well-known amino-acids which consist of benzene compounded with other chemical groups, and are named phenyl-alanine, tyrosine, and tryptophan. These substances when treated with strong nitric acid, and boiled for a few seconds, give a yellow colour, and if the mixture be cooled and ammonia added the colour changes to orange. Now, if a protein solution gives a similar reaction, we conclude that it contains at least one member of the above three amino-acids. In this sort of way a large number of tests have been evolved by means of which we can say whether a protein does or does not contain a specific amino-acid or a member of a group of amino-acids. Such tests are chemical tests for amino-acids, and are very commonly used in the routine analysis of proteins. But such tests tell us nothing about the properties of the protein as a whole. By boiling the proteins with strong acids it is possible to break down the linkages and liberate the amino-acids so that they can be estimated quantitatively. This is very important for our knowledge of the constitution of the proteins, but it tells us nothing of the properties of the protein as a chemical individual.

The protein with which we are most commonly familiar is that contained in egg-white. Egg-white contains the proteins ovo-albumin and ovo-globulin, which, when examined in the natural state, appear fluid and rather sticky. The stickiness of egg-white is due to the presence of another protein, ovo-mucin. These proteins are present in what is called the colloidal state, and can be made to coagulate or solidify by being heated. Thus these proteins are called coagulable proteins. Egg-white is alkaline. If a little acetic acid be added to whisked egg-white, so as to neutralize it, and if then four or five times as much water as egg-white is poured on the mixture, a precipitate forms; this consists of ovo-mucin and ovo-globulin. The ovo-albumin remains dissolved. Thus we see that globulin is insoluble in water whilst the albumin is soluble.

Milk contains three proteins: caseinogen, which is rich in phosphorus, lact-albumin, and lacto-globulin. By adding acetic acid to milk a precipitate of casein—in which fat is entangled—is formed. Removal of the casein and fat leaves a turbid fluid which contains a globulin and an albumin. It must be realized that globulins and albumins differ in composition according to the source from which they are obtained; though they resemble one another in the group reactions. The albu-

mins from egg-white, milk, and blood serum are all different in chemical composition, containing as they do different amounts of the amino-acids per unit weight. For example, egg albumin contains 1·3% of tryptophan (an amino-acid absolutely essential to normal metabolism), but milk albumin contains 2·7%; on the other hand the former contains 4% of tyrosine (another essential amino-acid), whilst the latter contains only 1·9%.

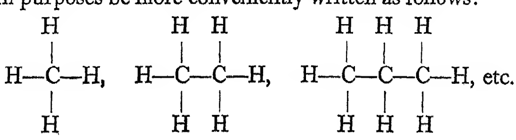
The proteins cannot as yet be classified by purely chemical means; we have to rely to a great extent on physical criteria, such as solubility in water, or alcohol, or acid, or alkali, or dilute salt solutions, and so on. The proteins of flour, for example, are called gliadin and glutelin. Gliadin is soluble in 75% alcohol, and glutelin is soluble in alkali. When water is added to flour, the familiar doughy sticky mass called gluten is formed; this is due to the action of water on the gliadin. Rice and oats, therefore, which are very poor in gliadin, do not give a dough with water. Again, gliadin contains over 40% of a certain amino-acid called glutamic acid, which by far exceeds the quantity of this substance present in the other proteins.

CONSTITUTION OF AMINO-ACIDS.

We have seen that proteins consist of chains of amino-acids linked together in a special way, and that the amino-acids result from a special combination of an organic acid and ammonia. We must examine shortly the structure of an amino-acid if we are to understand how it enters into metabolism.

'Organic' is the name given to the vast number of chemical compounds which contain carbon. This term has no reference to the presence of such compounds in the body, and in fact, the number of organic substances which are detectable in the body is small.

One class of organic compounds is that comprising substances which consist solely of carbon and hydrogen, and are, therefore, called hydrocarbons. The composition of such hydrocarbons is represented by formulae such as CH_4, C_2H_2, C_6H_6, the numbers referring to the number of atoms of the corresponding elements which are present in the molecule of the compound. The three formulae given are those of methane (marsh gas), acetylene, and benzene. Now the properties of hydrocarbons differ very widely according to the relative numbers of carbon and hydrogen atoms they contain, and it has been found convenient to classify them on such a basis. Thus the series of compounds which contain two more hydrogen atoms than twice the number of carbon atoms is called the paraffin series. Such a series contains the following members: CH_4, C_2H_6, C_3H_8, C_4H_{10}, etc. These formulae may for certain purposes be more conveniently written as follows:



the carbon atoms being arranged in chains and each carbon atom having four links or bonds which are filled either by hydrogen or by attachment to a bond of another carbon. Carbon atoms have the important property of being able to hold in chemical combination four atoms of hydrogen or the equivalent of four such atoms. Thus we can substitute for one of the hydrogen atoms of methane one atom of the gas chlorine, and obtain CH_3Cl (the symbol Cl standing for one atom of chlorine), which is called methyl chloride, or, better, mono-chlormethane. If two atoms are thus substituted we get CH_2Cl_2, or di-chlormethane. Again, if we substitute the important group OH—called hydroxyl—for the hydrogen of methane we get CH_3OH, which is methyl alcohol; alcohols being partly characterized by the group OH. Similarly, by substituting OH for one of the hydrogens of ethane we get C_2H_3OH, which is ethyl alcohol, the alcohol of everyday use.

Now the group which is of particular interest to us in connection with amino-acids is the so-called carboxyl group, COOH, formed of one atom of carbon, two atoms of oxygen, and one atom of hydrogen. This group is characteristic of organic acids, and can only exist in combination with other groups. Thus, formic acid is H—COOH, acetic acid is CH_3—COOH, propionic acid is CH_3—CH_2—COOH, and so on. Acids so constituted are called fatty acids, and have a great importance in metabolism. The higher members of the fatty acid series, palmitic and stearic acids, when combined with glycerine, give the ordinary fats of the body. Acids containing in their molecule one carboxyl group are called mono-carboxylic acids; these as we have seen may be regarded as derived from the substitution of one COOH in the hydrocarbon molecule. If two COOH groups are thus introduced in the hydrocarbon molecule we obtain a di-carboxylic acid: an example of a di-carboxylic acid is $CH_2(COOH)_2$, malonic acid, which is obtained from the acid present in unripe fruits.

Let us now examine the chemical nature of the other constituent of the amino-acids, namely ammonia. Ammonia is a gas which is very soluble in water, giving a strongly alkaline solution. Ammonia consists of nitrogen and hydrogen chemically united, and its chemical formula is NH_3. The atomic weight of hydrogen is taken as 1, and that of nitrogen is found to be 14; hence the molecular weight of ammonia is 17, so that 17 parts of ammonia contain 14 parts of nitrogen.

Now if we take a fatty acid, say acetic acid ,CH_3COOH, and make it react with ammonia by special methods (mere addition of ammonia to acetic acid will not do), a compound is obtained of the following structure:

$$\begin{array}{c} \mathrm{H} \\ | \\ \mathrm{H—C—COOH} \\ | \\ \mathrm{NH_2} \end{array} \quad \text{or} \quad \mathrm{CH_2—NH_2—COOH}$$

i.e. the acetic acid and the ammonia have joined together with the loss of two hydrogen atoms. Such a compound is called an amino-acid. The particular one given is called amino-acetic acid or glycine. Propionic acid and ammonia give amino-propionic acid or alanine, CH_3—CH—NH_2—COOH. Amino-acids may contain one NH_2 group, or two such groups; and the amino or

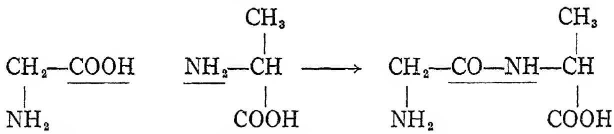
NH_2 group may be present in a mono-carboxylic acid or in a di-carboxylic acid.

Several other groups than the simple fatty acid may enter into the composition of an amino-acid, but these will be referred to as they become relevant.

THE PROTEIN LINKAGE.

It has already been pointed out that proteins are built up of chains of amino-acids, and it will be convenient to examine now how this linkage occurs. The justification of the assertion that amino-acids are linked in this way is mainly based on the fact that substances formed by the chemist using this method possess properties very similar to those of proteins.

Let us take the two simplest amino-acids, viz., amino-acetic acid and amino-propionic acid, and link them together in the way they are probably linked together in the protein molecule. We write the formulae in such a way that the process is easily followed.



Amino-acetic acid (Glycine) | Amino-propionic acid (Alanine) | Glycyl-alanine

What happens is simply that the carbonyl group (COOH) of one acid reacts with the amino group (NH_2) of the other acid, and by the elimination of the group H_2O, which is really water, a new group, CO—NH, is formed in the middle of the new compound. Such a compound of two amino-acids is called a di-peptide; the names given to such substances are formed according to the common names of their constituent amino-acids. If three are linked together the result is a tri-peptide, and the general name given to this class of compound is poly-peptide. Proteins consist of chains of polypeptides formed from some twenty amino-acids; this gives us some idea of the complicated nature of these constituent elements of living matter.

METABOLISM OF PROTEINS.

The organism on being presented with protein in the diet is faced with several problems. It has got to break down the protein into its constituents amino-acids, then absorb them into the circulation, and so deal with them that new tissue may be built up to replace wear and tear. In addition, it has got to synthesize the necessary internal secretions from the amino-acids, and also make a proportion of the amino-acids available for energy purposes. The preparation of the proteins for metabolism begins in the stomach and small intestine, and is described in the section dealing with digestion. For our present purposes it can be shortly stated that the digestion of protein

consists in a series of complex reactions taking place in the gastro-intestinal tract, and has for its object the breaking of the linkages which hold together the amino-acids in the protein, and so free them that they can be absorbed into the blood. Diet protein is only of use to the organism in so far as it can be broken down into amino-acids.

The amino-acids having been absorbed, a complex series of changes occur, of which our knowledge is in many respects fragmentary. Certain matters, however, seem to be relatively clear.

If a protein is to be of value in the building up of new tissue it must contain among its amino-acids the following three: phenyl-alanine, tyrosine, and tryptophane, because the manufacture of new protoplasm is impossible without these substances. Consider the familiar protein, gelatin, obtained by boiling animal connective tissues with dilute acids. It is so poor in tyrosine and tryptophane that as an exclusive source of protein it is useless.

The adult organism must be considered as being in a state of complex equilibrium, and one of the indices of this equilibrium is the relation between the amount of nitrogenous matter which is absorbed and the nitrogenous waste matter which is excreted. Compounds containing nitrogen are constantly found in the urine and faeces of animals and of man. Whether food is taken or not, nitrogenous compounds are excreted. We can speak of protein metabolism as nitrogen metabolism, since fats and carbohydrates do not contain nitrogen. Any nitrogenous compounds in the urine and faeces must come from protein metabolism. So, during starvation, the amount of excreted nitrogenous matter will be a measure of the amount of tissue protein that is being broken down or katabolized; this will give us a good idea of how rapidly a fasting man is going down hill. During normal dietary conditions the amount of nitrogenous matter excreted over a period is equal to the amount absorbed; or, put in another way, the amount of nitrogen in the excreta is equal to the amount of utilizable nitrogen in the food taken over the same period. When this is the case the subject is said to be in *nitrogenous equilibrium*. If, however, the protein eaten does not contain the essential amino-acids above referred to, no amount of it can bring the body into this state of equilibrium. So, if the sole source of protein is, for example, gelatin, nitrogenous equilibrium cannot be attained, and the essential amino-acids for repair will not be available.

From these facts we may enunciate the general proposition that *Nitrogenous Equilibrium cannot be attained unless certain amino-acids are present in the diet*. In addition to the three already mentioned, the following three are also to be included in the essential amino-acids, since the body appears unable to synthesize them: histidine, lysine, and a very important one called cystine, which contains sulphur.

Existence on a diet which is deficient in these amino-acids is not unlike starvation.

The conception of nitrogenous equilibrium brings us to the peculiar power which the body possesses of adjusting itself to different conditions of protein intake. If the diet of a man is so arranged that he receives a considerable excess above his requirements, it is found after a few days that his metabolism is so adjusted that he is again in nitrogen equilibrium, i.e. his tissues soon learn to deal with the excess food protein and his processes become keyed up to a higher level than before. The reverse process of keying down to a lower level of nitrogenous metabolism occurs if we then lower his diet to the former quantities.

DE-AMINATION OF AMINO-ACIDS.

We must now see how the body deals with the amino-acids which it absorbs from the digestion of protein. There is much in this process which scientists are very doubtful about, and the description here given will be the barest outline of it.

It must be conceived that at all times there is a greater or lesser stream of amino-acids in the blood. These amino-acids may be coming from the protein digested in the intestine or from the breakdown of the body's own protoplasm, and their fate will vary according to the necessities of the moment. If there is a need for repair of tissues, those parts in need of repair are able to draw on the blood and tissue fluids for the necessary amino-acids. If there is a need for energy-giving material, the tissues (muscles, heart, kidneys, etc.) will draw on the same source, but in the latter case the amino-acids must go through a special process before they can be available for use. This special process has for its object the separation of the nitrogen-containing part of the amino-acid from the fatty acid part, and is called de-amination.

De-amination can probably occur in most tissues in the body, but it takes place mainly in the liver. The amino-acids reach the liver through its blood-supply, and come into intimate contact with the complicated system called the liver cell. Here they are acted upon by peculiar agents called enzymes. All we can say about enzymes here is that they are substances produced by living cells, and that they have the property of making biological reactions occur at a great speed. The changes undergone by food in the stomach and intestine depend largely upon enzyme action. If we had to rely on ordinary chemical means to effect the necessary changes in food, it would take much longer to produce the same effects. Enzymes may be looked upon as the tools used by living cells to bring about rapid chemical changes so that the body may be supplied with necessary and suitable material. One example of a familiar enzyme will have to suffice here. Yeast, which

consists of living cells, produces an enzyme which is called zymase. Yeast cells can live on sugar, and in doing so they use their enzyme zymase to split up the sugar molecule. This splitting or fermentation of the sugar gives the yeast its energy and gives us, as a sort of by-product, alcohol. One additional point must be borne in mind. There are a large number of enzymes, and it is a very strange fact that they are specific in action, i.e. each enzyme will act on a particular substance, and no other.

The liver is richly supplied with a whole host of enzymes, and among them are some the special function of which is de-amination. Whatever the intermediate stages may be, the final result is to produce from the amino-acids ammonia and a fatty acid derivative.

$$\text{AMINO-ACID} \xrightarrow[\text{Enzymes}]{\text{Liver}} \text{AMMONIA and FATTY ACID DERIVATIVE}$$

The fatty acid derivative may be regarded as undergoing changes similar to those described in later sections; the ammonia liberated must here be examined more closely.

The ammonia as soon as it is liberated combines with carbon dioxide, which is always available in the tissues, and forms ammonium carbonate. The ammonium carbonate is then broken down in two stages to form a very important substance, *Urea.*

AMINO-ACID ⟶ AMMONIA ⟶ AMMONIUM CARBONATE ⟶ UREA.

Urea is a white crystalline substance, and is very soluble in water. It contains 47% of nitrogen, and constitutes between 80 and 90% of all the nitrogenous waste matter in the urine. About thirty grams (28 grams are equal to 1 ounce) of urea are excreted per day by a normal man on an average diet. Urea appears to be quite useless to the animal body, and is excreted by the kidneys soon after it is formed in the liver. It is always present in the blood and tissue fluids, thus indicating that protein metabolism is always going on.

In normal circumstances all the ammonia split off from the amino-acids is changed into urea; but if there is disease of the liver this change may be carried out inefficiently, so that ammonia accumulates—or there may even be an accumulation of amino-acids due to failure of de-amination.

In certain diseases characterized by an abnormal production of acids in the tissues (e.g. in diabetes) the body uses the ammonia of de-amination for neutralizing these acids, so that less urea is formed, and more ammonia is found in the urine. In conditions where there is a tendency to alkalinity (e.g. in continued vomiting), all the ammonia is changed into urea, and hardly any can be detected in the urine.

The metabolism of protein may be summed up in the following scheme:

Food protein — Tissue protein

Digestion in the gastro-intestinal tract

Breakdown to amino-acids

Amino-acids carried to liver and tissues

De-amination, mainly in the liver — Repair of tissue

Ammonia — Fatty acid derivative

Ammonium carbonate

UREA — (See Fat Metabolism)

Fat Metabolism

The fats are compounds of glycerine and higher fatty acids. Glycerine is rather like an alcohol in chemical structure, and one molecule of it can combine with three molecules of fatty acid, the result being a fat or an oil. Fat is insoluble in water, as is readily seen if whole milk is allowed to stand, when the cream (18% fat and 75% water) rises to the top as a separate layer. Fat is lighter than water. Cream is an emulsion of fat in water, i.e. the droplets of fat are suspended in a watery medium. The churning process changes the cream so that the water globules are now suspended in a fatty medium. Butter (81% fat and 11% water) may be regarded as a suspension of water in fat.

The emulsification of fats is a very important process in their digestion. It consists mainly in the splitting up of the fat into such small globules that they can remain in suspension for a very long time. Fats may be of vegetable or of animal origin.

The emulsified fat passes into a system of fine vessels called lacteals,

which arise from the inside of the intestine. These tubes swell up and become full of a milky fluid when fat is being absorbed. The fat is carried by means of the lacteals to the blood, and it is easy to recognize an increase of fatty globules in the blood during active digestion. The fat is distributed by the blood to all parts of the body where, according to circumstances, it may be oxidized (i.e. burnt for energy purposes), stored, or changed to other substances needed by the organism.

STORAGE OF FAT.

This will occur when the amount of fat taken in the diet exceeds the needs of the organism. The fats of different animals differ in composition; so that, if we eat butter, which is bovine fat, or mutton or pork fat, important changes have to be effected in order that human fat may be formed.

The fat which is laid down in our bodies does not necessarily arise from fat as such. We have seen that fatty acid derivatives arise during the metabolism of protein, and such compounds can lead to fat deposition. Animals can be fattened even on a diet of almost fat-free food; especially if the diet contains a great excess of sugar. Starch or sugar is, indeed, the main source of fat in most obese individuals.

As has been said before, fats contain no nitrogen; they consist entirely of carbon, hydrogen, and oxygen; hence the body cannot be sustained on fat alone. Fortunately, the forms in which fat is usually eaten include considerable amounts of protein. The Eskimos, who eat large quantities of fatty substances because of their high heat value, have to supplement their diets with protein matter such as fish or flesh.

FAT-LIKE SUBSTANCES IN THE BODY.

In addition to the ordinary fats, the body also contains other substances resembling fats, the functions of which are imperfectly known. These bodies are called lipoids; and they consist of combinations of fats, phosphoric acid, and a complicated substance called choline. These lipoids are found in almost every tissue in the body. We have referred to a derivative of choline, viz. acetyl-choline, as being the agent responsible for the inhibition of the heart; and it may be that the lipoids have some intimate relation to the function of nerves, for nervous tissue is particularly rich in lipoids. Egg yolk is also rich in these compounds.

OXIDIZATION OF FATS.

The main value of fat to the organism lies in the great amount of energy or heat which can be obtained from it. Weight for weight, we

get more than twice as much heat from fat as from protein or sugar. This heat is made available by 'burning' the fat, that is, by oxidizing it. As has been said, fat consists of glycerine and fatty acids, and the only elements involved are carbon, hydrogen, and oxygen. The oxidization of fat may be thus expressed:

$$\text{FAT OXIDIZATION} \begin{cases} \text{Glycerine} + \text{Oxygen} \longrightarrow \text{Carbon dioxide} + \text{Water} \\ \text{Fatty acids} + \text{Oxygen} \longrightarrow \text{Carbon dioxide} + \text{Water} \end{cases}$$

The 'engine' in which this occurs is the body, and in normal conditions there is no 'smoking,' i.e. the fat is completely converted into the gas carbon dioxide and the liquid water. This kind of burning or complete combustion is possible outside the body only at a high temperature and in the presence of a free supply of oxygen, otherwise compounds are formed as a result of incomplete combustion. Such products will readily be detected if fat or oil is thrown on to a hot plate or pan. In certain circumstances the body also burns fat incompletely, but we will return to this later.

How does the body completely oxidize the fat? Does it simply take the fat molecule, break off the carbon, and burn it to carbon dioxide, and do likewise with the hydrogen, and use the oxygen in the fat as best it can? Whilst in a certain sense this is what it does, the process is by no means so direct a one as such a description would suggest. As in the case of protein metabolism, we will give a simple view of the breakdown of the fat molecule in the body.

The tissues, especially the liver, possess enzymes which can split the fat into its component parts, glycerine and fatty acid, and these are then dealt with more or less separately.

METABOLISM OF GLYCERINE.

Evidence as to how the body deals with glycerine is conflicting, but it is probable that a good deal of it is changed into a sugar (glucose) before it is burnt away. Keeping in mind what was said about fatty acids and their chemical formulae, it should be easy to understand the following: Glycerine is

$$\left.\begin{matrix} CH_2OH \\ CHOH \\ CH_2OH \end{matrix}\right\} \text{ or } C_3H_8O_3, \text{ and in the body this readily changes to } \left\{\begin{matrix} CHO \\ CHOH \\ CH_2OH \end{matrix}\right\} \text{ or } C_3H_6O_3$$

The latter compound is called glyceric aldehyde, and two molecules of it can join together and form one molecule of the sugar glucose, the formula of which is $C_6H_{12}O_6$. Now glucose is a sugar which the body readily metabolizes, so the problem of the oxidization of glycerine becomes that of glucose (see next section). It is interesting to remember this because one-fifth of the weight of fat is glycerine, and so it appears that when we talk of the

metabolism of fat we are automatically forced to consider the metabolism of sugar.

METABOLISM OF FATTY ACIDS.

The fatty acids occurring in the body are characteristic in that they have an even number of carbon atoms in the molecule. Fatty acids are known which have uneven numbers of carbon atoms, but these do not occur in the body. The three important fatty acids recognized in animal fats are the following:

Stearic acid,	Oleic acid,	Palmitic acid;
$C_{17}H_{35}COOH$	$C_{17}H_{33}COOH$	$C_{15}H_{31}COOH$

their structure is better represented in chain form:

$$
\begin{array}{ccccccccccccccccccc}
 & H & H & H & H & H & H & H & H & H & H & H & H & H & H & H & H & H & \\
 & | & | & | & | & | & | & | & | & | & | & | & | & | & | & | & | & | & \\
H\text{—} & C\text{—} & C\text{—} & C\text{—} & C\text{—} & C\text{—} & C\text{—} & C\text{—} & C\text{—} & C\text{—} & C\text{—} & C\text{—} & C\text{—} & C\text{—} & C\text{—} & C\text{—} & C\text{—} & C & \text{—COOH} \\
 & | & | & | & | & | & | & | & | & | & | & | & | & | & | & | & | & | & \\
 & H & H & H & H & H & H & H & H & H & H & H & H & H & H & H & H & H &
\end{array}
$$

is stearic acid, and palmitic acid is simply one group CH_2 shorter. Observe that each carbon in the chain has four links all fully occupied. In order to make a similar formula for oleic acid it is necessary to leave two of the carbon links unfilled, and we express this unfilled condition as follows: $\text{—}\underset{\substack{|\\ H}}{C}=\underset{\substack{|\\ H}}{C}\text{—}$

the double link or bond indicating that each carbon atom is potentially able to combine with another hydrogen atom or its equivalent. Fatty acids in which no double bonds occur are said to be saturated; those in which such double bonds do occur are said to be unsaturated. In general, compounds which have double bonds are more reactive chemically than those which have no such bonds.

When presented with the problem of metabolizing a fatty acid the body uses two main stages:

(1) The fatty acids are dealt with in the liver and de-saturated, i.e. hydrogen atoms are split off the chain, and new acids are formed with more double bonds than the original acid.

(2) The de-saturated acid is now subjected to a process by which two carbon atoms at a time are split off the fatty acid chain. In this way the fatty acid is 'niggled' away. The 'niggling' begins at the end with the carboxyl group in the following way:

$CH_3\text{—}CH_2\text{—}CH_2\text{—} \ldots CH_2\text{—}CH_2\text{—}COOH$ i.e. $C_{17}H_{35}COOH$

$\downarrow$

$CH_3\text{—}CH_2\text{—}CH_2\text{—} \ldots CH=CH\text{—}COOH$ i.e. $C_{17}H_{33}COOH$

$\downarrow$

$CH_3\text{—}CH_2\text{—}CH_2\text{—}\ . \quad COOH\ \ CH_3COOH$ i.e. $C_{15}H_{31}COOH+CH_3COOH$

This is a rather arbitrary way of representing a very complex process, but it will serve to present the principle involved. Each stage of the process

yields one molecule of acetic acid, and leaves a fatty acid with two carbon atoms less than the preceding one contained. Thus, since the fatty acids in the body always contain an even number of carbon atoms, the whole molecule can be considered as split up into molecules of acetic acid. The oxidation of the fatty acid molecule is thus resolved into the disposal of acetic acid. One well-known worker on this subject has said that the oxidation of fatty acid by the body consists of a series of micro-explosions of acetic acid. We must conceive that each molecule of acetic acid as it is formed undergoes immediate oxidization to carbon dioxide and water. In this way the fatty acid molecule is normally completely disposed of without residue.

Carbohydrate Metabolism

Carbohydrates are so called because they consist of carbon, hydrogen, and oxygen, the last two elements existing in the molecule in the proportions in which they occur in water. The carbohydrates of importance to us are the following:

Starch is a carbohydrate of vegetable origin, and is the form in which carbohydrate is stored in the plant. Starch is readily changed into glucose by the action of certain enzymes—ptyalin in saliva, and amylase in the secretion of the pancreas.

Glycogen might be called animal starch, and is the form in which the body stores carbohydrate, so that it may later be changed into the utilizable form of glucose. Glycogen is found in almost every tissue in the body, but is especially rich in the liver, the muscles, and the heart.

Cane Sugar is the sugar of everyday use, and is quickly changed in the intestine by means of the enzyme sucrase into two sugars, glucose and fructose. These have the same chemical formulae; but the arrangements in the molecule are different, and they have different properties. For example, fructose is sweeter than glucose, and is more soluble in water.

Lactose is the sugar of milk. On absorption into the intestine it is acted upon by a specific enzyme, lactase, and changed into two sugars, glucose and galactose, before entering the blood. The production of lactose in the milk of the breast does not depend on the lactose taken by the mouth; it is synthesized by the breast-gland in some unknown way from the sugar in the blood, glucose.

Glucose is the sugar of the blood. It is also the sugar of the grape. The body readily uses it for energy purposes. It is constantly being liberated from glycogen in the liver, and carried to the blood and tissues.

TWO IMPORTANT PROPOSITIONS.

(1) The whole cycle of normal metabolism depends on the proper metabolism of glucose. The whole metabolic machine goes wrong if the metabolism of glucose goes wrong.

(2) Normal glucose metabolism depends on the proper production of glycogen. Failure to form glycogen in the body leads to abnormal carbohydrate metabolism.

Let us suppose that some starch is taken by mouth, and let us follow it through the principal stages which occur in its metabolism.

Stage 1. The starch is acted upon in the mouth by the salivary enzyme ptyalin. The starch is felt to become somewhat sweet owing to the change to maltose or malt-sugar, which is brought about by the action of the enzyme on the starch. The maltose and unchanged starch pass into the stomach, where the ptyalin becomes inactive owing to the acid which is produced in the stomach. This acid may to some extent itself promote the change to maltose.

Stage 2. The maltose-starch mixture now passes to the small intestine, where it meets two important enzymes, which complete the change of starch to maltose, and further change the maltose to glucose. These two enzymes are respectively amylase produced by the pancreas, and maltase produced in the glands of the intestinal wall. The starch is thus all converted into glucose, and this is rapidly absorbed into the blood, the increase in the blood sugar being readily detected.

Stage 3. Some of the sugar is rapidly carried to all the tissues in the body, in which it undergoes a series of complex changes, but it will be sufficient if we concentrate on the final results.

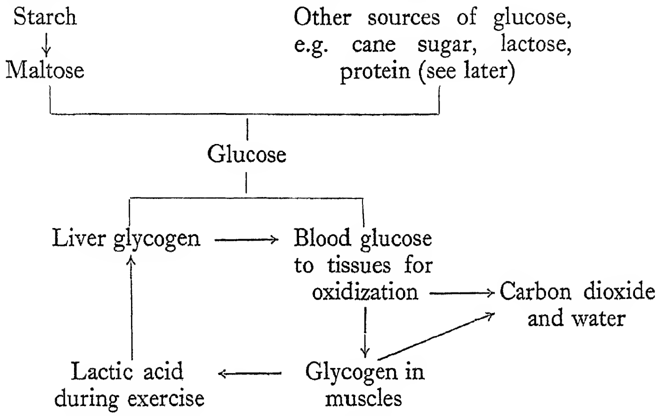
The flooding of the tissues with an increased amount of sugar is followed very rapidly by a rise in the oxidizative processes and especially an increased sugar utilization. This increase in the metabolism of sugar does not last long, even when absorption is still going on from the intestine.

Sugar absorbed from the intestine first passes by the portal circulation into the liver. The flare-up in metabolism just referred to is associated with the passage of some glucose straight through the liver to the muscles and other tissues. But simultaneously with this passage through the liver, sugar is being converted by the liver cells into glycogen, and held back in the liver itself.

Stage 4. This is the stage of storage and control. The rapid release of all the sugar absorbed would obviously be a wasteful process, since it would either lie dormant in the blood, and possibly pass out into the urine, or it would keep up a high rate of metabolism, with no other result than to produce heat to be radiated away. The excess sugar is changed into glycogen, which is readily stored in the liver and in the

muscles, as well as in other organs. Later as necessity arises this glycogen can be changed back into glucose, and released for oxidization.

Schematically represented the process is somewhat as follows:



Certain matters in this simplified scheme must be shortly referred to:

(*a*) Liver glycogen may be regarded as a store from which glucose is released as required. It is reserve carbohydrate.

(*b*) Glucose carried by the blood to the muscles is also changed to glycogen by the muscle-cells, and it is probable that it is used by the muscle as glycogen.

(*c*) During muscle contraction, as in exercise, muscle glycogen is broken down to lactic acid. Whereas liver glycogen is released from the liver as glucose, muscle glycogen is always released as lactic acid.

During muscular exercise lactic acid is liberated from muscle glycogen and a great increase of this acid is detectable in the blood. The fate of this lactic acid depends on circumstances; it is in part oxidized, in part changed back to muscle glycogen, in part converted to glycogen in the liver and partly lost in the urine. In each case, except the last, the lactic acid is not lost to the body; but becomes available again as either glycogen or energy.

(*d*) The final fate of the carbohydrate, taken in whatever form, is that it is oxidized away to carbon dioxide and water, with the liberation of a certain amount of energy.

Total Metabolism

From the quantitative point of view, total metabolism means the amount of heat produced by the body in a given time.

Heat is measured in calories.

A calorie is the amount of heat required to raise the temperature of a litre of water 1° C., i.e. $1\frac{3}{4}$ pints of water 1·8 F.

By various direct and indirect methods which we need not describe it is possible to measure the amount of heat produced by a man or an animal. When this is determined with the subject at rest, and after about fifteen hours without food, we speak of the heat production or metabolism as basal metabolism. In order to be able to compare different people in different conditions it is necessary to have some sort of standard, and the standard taken is the amount of heat produced per square metre of body surface per hour. We find the amount of heat produced per hour, and divide this by the surface area of the subject; the latter being calculated by means of a formula depending on the height and weight of the individual. The basal metabolism is different at different ages and for the different sexes. The following table gives average values for boys, men, and women.

	Age	*Basal Metabolism* (Calories per sq. metre per hour)
Boys	12–13	50
Men	20–50	40
Women	20–50	37

Thus the basal metabolism is higher in youth than in middle age, and is greater in the male than in the female. In old age the basal metabolism is less than in middle life.

When investigating the basal metabolism, it is usual to express the result as a percentage difference from the standard average values for the age and sex of the subject. So, if we say that the basal metabolism is +10% we mean that it is 10% above the average value associated with the age and sex of the particular individual under consideration. The range of variation which is found to include the normal is about 10% both ways, i.e. if a result is +10% or − 10% we still consider it normal. Values outside this range are regarded as abnormal.

Let us consider a normal man of about thirty years, height five feet eight inches, and weighing eleven stone. The surface area of such a man is 1·8 square metres (1 square metre is equal to 10·77 square feet). Then the basal metabolism of such a subject is $40 \times 1{\cdot}8$ calories per hour, i.e. 72 calories per hour. Therefore in one day he produces 1,728 calories. This is the amount of heat he produces basally, that is, without food and at rest. Work will, of course, increase the metabolism, and the source of the increase must either be his own tissues or his food. One can calculate a diet on the basis of the amount of work a man is to perform, but this is unnecessary normally, because the

organism regulates automatically (by means of appetite) the quantity of food necessary.

The amount of energy obtainable from a diet will depend not only on its quantity, but also on its make-up. The heat obtainable from a given food is called its *calorific value.*

1 gram (15·4 grains) of	protein	yields	4·3	calories.
1 ,,	fat	,,	9·5	,,
1 ,,	carbohydrate	,,	4·2	,,

Provided we know the amount of each of these food types in the diet eaten it is simple to calculate the heat value. Let us take, for example, ordinary white bread, containing of available energy-giving matter: 7·1% protein, 1·2% fat, and 52·3% starch. From this we calculate that the heat value of 1 lb. (453·6 grams) is about 1,190 calories. Beef steak contains 22·8% protein, and 19·4% fat, and no carbohydrate at all. From this we calculate that 1 lb. cooked beef steak gives about 1,290 calories of heat. Butter is 81% fat and only 1% protein; from which we find that 1 lb. butter yields 3,400 calories.

VIII—THE NERVOUS SYSTEM

THE nervous system is the master system of the body, and through it alone the body is put in touch with the outside world, and is enabled to adjust its movements in accordance with what is seen, heard, tasted, smelt, and touched. We are apt to think of the brain as the seat of our intelligence, and it is true that man is distinguished from his cousin, the ape, chiefly by his highly developed forebrain; but it is well to remember that this distinction of ours has been—geologically speaking—only recently acquired, and is still more easily thrown out of gear than the older, more primitive, and more firmly established elements of the nervous system.

ANATOMY

Those of us who have ever looked round a butcher's shop know roughly what our own brains look like. In colour the brain is white with grey patches; in substance it is soft and of the consistency of a blancmange. The brain, as we know, is strongly encased in that strong bony box, the skull, and the spinal cord in the flexible bony canal formed by the vertebral column. Nerves from the brain—the cranial nerves—issue from various openings in the skull, and go to the ear, the eye, the nose, the mouth, and the skin and muscles of the face. These nerves, situated at the head end of the body, the end that thrusts its way inquiringly into the world, are obviously of great importance. They are twelve in number. Three of them govern the movements of the eye, and one transmits to the brain the stimuli of light that fall upon the retina at the back of the eyeball. Of the other eight nerves, one subserves the sense of smell; one that of taste and sensation on the skin of the face, and governs the movements of the jaw; one controls the muscles of expression; one conveys sound-messages to the brain; another looks after the muscles of the tongue; another after those of the upper part of the gullet; another deals with certain muscles of the neck and shoulder; and, finally, there is the important nerve that first supplies the muscles of the palate, of the upper part of the gullet and of the vocal cords, and then continues, deep in the neck, to branch out to the lungs and the heart and, not content with this, ends by sending branches to the stomach and intestines.

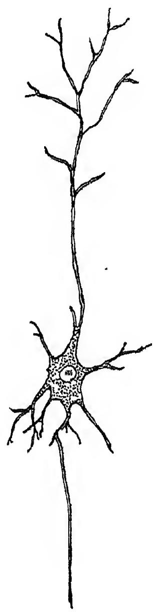
From the spinal cord nerves run out through the gaps between the

vertebrae to every nook and cranny of the body. Both the spinal cord and brain are covered with skins or membranes called the meninges (meningitis, as is explained elsewhere, is an inflammation of these membranes). The cord and the brain are bathed in the cerebro-spinal fluid, which acts as a buffer to protect them from jolts and jars.

Nerves are functionally of two kinds: motor nerves, which excite muscles to contract; and sensory nerves, which receive messages from the outside and inside world, and convey these messages to the spinal cord and brain.

THE NEURONE.

The nervous system consists of nerve-cells and nerve-fibres. These cells and fibres are grouped in an orderly way in the central nervous system, the brain and the spinal cord, and the fibres gather in bundles which, as we have already seen, reach the various parts of the body by passing through holes in the skull and between the vertebrae.



NERVE CELL

The neurone is the nervous unit, and the nervous system is but a collection of these units, held together in a supporting framework. The neurone consists of a nerve-cell; a nerve-fibre called the axon, which grows out of the cell and may be several feet long; and short branching fibres called dendrites, which also grow out from the cell. The dendrites come into contact with dendrites of adjacent cells. Nerve-fibres are for the most part enveloped by a fatty sheath; certain of them do not possess this sheath. The long fibre, the axon, may go, with axons from other cells, to a muscle or to a sense organ, or to any other organ of the body; or it may end in contact with another nerve-cell, the latter forming a sort of relay station. There is no anatomical continuity between one neurone and another; but there is physiological—that is, functional—continuity, and the area of junction between the axon of one cell and the dendrites of another (or between two sets of dendrites) is called a synapse. A nerve impulse may pass in both directions along an axon, but it only passes in one direction between one neurone and another, the synapse between the two acting, so to say, as a one-way valve. This ensures that nervous impulses pass in one direction only along a certain group of neurones. This one-way traffic-system for nervous impulses preserves the nervous system from chaos.

The largest nerve-fibres are something less than one-fiftieth of a

millimetre in thickness. The nature of the nerve impulse is unknown, but it is known that the passage of an impulse along a nerve is accompanied by electrical changes, and also by chemical changes. The velocity of a nerve impulse is in the region of one hundred and twenty metres a second.

Physiology

THE REFLEX.

A reflex may be defined as an automatic response of a muscle or a gland to an appropriate stimulus. The word 'automatic' implies an involuntary action beyond the control of what we call the will. An irritating article is blown into your eye and you automatically blink. A doctor taps your knee with a rubber hammer and your leg jerks forward. They are reflex actions which you do without thinking.

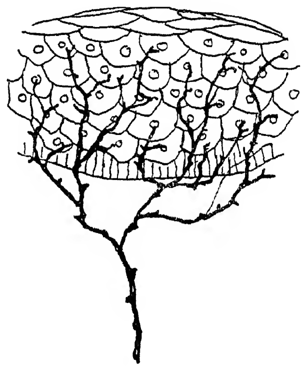
For the simplest kind of reflex involving the central nervous system to take place, there must be: (*a*) an organ for receiving the stimulus—the skin, the eye, the ear; (*b*) a sensory neurone to convey the stimulus from the receptor organ to the central nervous system; (*c*) a motor neurone to convey the message to (*d*) a muscle or gland to carry out the necessary and effective response: (*a*), (*b*), (*c*), and (*d*) constitute what is called the reflex arc. Just as the neurone is the anatomical unit of the nervous system so is the reflex the physiological unit. In the simplest reflex arc, as we have seen, there must be two neurones—a sensory and a motor.

These are relatively simple reflexes, but experiments on animals and observation of human beings with diseased nervous systems show that there are a number of elaborate reflexes connected with the posture of the body. Standing upright and walking may be largely reflex in character, although the *intention* to stand or to walk is determined by the conscious will of persons carrying out these activities. The various reflexes that have been analysed by physiologists depend for their execution upon a complicated nervous pathway, and several neurones in the central nervous system are involved. It has even been suggested that the greater part, if not all, of the activities of a human being are reflex in character, and that, physiologically, human behaviour is just one reflex after another. This idea has been fostered by the work of the famous Russian physiologist, Pavlov. When food is placed in a dog's mouth saliva automatically flows—this is an automatic reflex action. If for a number of times food is presented to a dog simultaneously with the ringing of a bell Pavlov found that, subsequently, the ringing of the bell alone, without a meal being given, would make the dog salivate. This reaction has been, so to say, grafted on to the original reflex, and is called a conditioned reflex: the condition in this case being the previous association of bell-ringing with meal-times. By working

along these lines Pavlov has made many important physiological discoveries; and theorists have gone so far as to suggest that all human activity and behaviour is nothing but a complication of such conditioned reflexes. Life, according to this doctrine, is just a series of automatic responses to previous chance stimuli.

THE BASIS OF SENSATION.

Effective contact with the world depends upon an intact nervous system. This contact is maintained by an elaborate sensory apparatus, whose main function is to enable the body to make the muscular responses adequate to given circumstances at given moments. It makes it possible for you to jump on a bus just as it is passing you—not two minutes later.



SENSORY NERVE-ORGAN IN SKIN

The brain is essentially an organ for dealing with the sensory impressions that reach it: (*a*) from the outside world through the senses of sight, hearing, smell, taste, and touch; (*b*) from the muscles, tendons, and from the joint surfaces of bones; and (*c*) from the inside of the body—the heart, lungs, alimentary tract, etc. The reader is familiar with the obvious function of the eyes and the ears, but a closer analysis of other sensory elements will perhaps reveal to him a world of sensation he has not yet been aware of.

If we start with the skin it is evident from immediate experience that the sensory nerves that serve it convey sensations of touch, heat and cold, and pain to the brain. A famous neurologist, Sir Henry Head, once cut one of the sensory nerves supplying the skin of his hand. When the nerve 'grew again' it was found that the first sensations to return were those of pain, heat, and cold, and that at first only certain spots on the skin responded to these stimuli of pain and temperature, the intervening areas remaining anaesthetic. It was also observed that localization of the stimulus was inaccurate, and that fine degrees of temperature were not appreciated: that is to say, there was no distinction between warm and warmer—only between hot and cold. Only crude forms of pain were recognized, and reaction to them was excessive. Later on there was a return of a finer sensibility. Small changes of temperature could be distinguished. The ability to say what part of the skin was touched came back, together with discrimination of touch: that is, Sir Henry was able to recognize two

compass points held close together as two distinct points when applied to the skin. This experiment showed that there were two kinds of sensory nerves supplying the skin: one set concerned with conveying crude sensations of heat, cold, and pain; the other with finer differences of pain and temperature and touch. We find, too, that different parts of the brain are concerned with the coming-into-consciousness of these generally cruder and more delicate sensory elements.

In the skin special little sense organs or touch corpuscles are distributed for picking up touch stimuli; they are especially found round the roots of hairs. It has been discovered that certain spots or areas in the skin are particularly sensitive to heat—hot spots—and to cold—cold spots. The cold spots are concentrated mainly on the chest, abdomen, and inner sides of the arm. Touch spots are concentrated on the finger-tips, the tongue, the nose, and the lips—the 'feelers' of the body.

MUSCLE SENSE.

If you shut your eyes you can touch the tip of your nose with a finger. You know without looking what your legs and arms are doing. And, in fact, an important group of sensations arising in muscles, tendons, and ligaments inform the brain of what is happening in these structures. These sensations tell the brain of the position of a limb in space, of the extent of movements, of the degree of pressure on joint-surfaces, of the tension of ligaments and tendons, of the pressure on muscles. This 'deep sensibility,' as it is called, is something quite different from the superficial sensibility of the skin. Accurate movement depends upon accurate information. And all the complicated movements of walking, talking, running, all movements of skill, depend upon the integrity of the sensory nerves that convey the 'feelings' of the muscles, etc., to the brain. In locomotor ataxy these nerves are destroyed, so that the patient is unable to walk properly or to perform accurate movements; not because the muscles are weak, but because sensory communication between them and the brain has been destroyed.

SENSORY PATHS.

These sensations we have described travel, when translated into nerve impulses, along the sensory nerves which ramify throughout the body to the spinal cord. Long nerve-fibres thence pass them up the spinal cord to the brain, where the message is interpreted and the appropriate muscular responses are initiated. A part of the brain called the thalamus, which lies concealed beneath the cerebrum or forebrain, and from an evolutionary point of view is the more primitive and ancient structure, is the part where pain, heat, and cold are experienced in consciousness. Here also are probably the nerve-centres for emotional

reactions, such as rage, and laughter, and instinctive actions and behaviour. In this connection it is interesting to note that the 'head station' for the sympathetic nervous system probably lies just below the thalamus. The sympathetic nerves are of a more primitive kind than those we have been considering, and stimulation of them gives rise to the physical changes observed in states of fear and rage: increased blood-pressure, fast pulse, dilated pupils, hair standing on end, increased blood sugar, immobility of the intestines, and contraction of the skin blood-vessels. All this is a physical preparation for fight or for flight. In close anatomical relation with the thalamus is the ductless gland called the pituitary, which, like all the ductless glands, is intimately concerned with growth and sex and emotional development. The ductless glands (acting by the chemical substances they produce), the sympathetic nervous system, and the thalamus are the three mechanisms which underlie primitive and instinctive reactions.

THE CEREBRAL CORTEX.

This is the part of the brain which is more highly developed in man than in other animals. Two lozenge-shaped masses either side of the mid-line extend from the forehead to the back of the skull, and are called the cerebral hemispheres. The cerebral cortex, or grey matter, consisting of layers of nerve-cells, is on the surface of these hemispheres, and tracts of nerve-fibres link these cells up with other parts of the brain and with the spinal cord. The cerebral cortex is like a telephone exchange. It receives messages from all parts of the world of the human being, interprets them, and puts the caller into the right contacts. One part of the brain deals with the sound messages from the ear, another with the visual messages from the eye, another with taste and smell messages. It has to receive and interpret all the sensory impulses coming from the skin, the muscles, the joints, and the internal organs. The sensory part of the cortex is discriminative. Here are appreciated differences in intensity—between warm and warmer, soft and hard, smooth and rough; spatial relations—the localization of touch, the extent and direction of displacement of limbs; similarity and difference—size, weight, form, texture of objects. Another part of the cortex governs the highly complex functions of speech: the word is heard, is read, is spoken, and is written. Someone dictates a sentence, the sounds enter the ear and the impulses set up travel along the auditory nerve to the brain, a cerebral conjuring trick takes place, and the writer correctly writes down the sentence on paper—the brain instructing the hand what to do. These complicated activities can only be performed if the nerve-cells and nerve-fibres in the brain are intact.

An important function of the cortex is to control or inhibit lower

nerve-centres of the brain. For example, if in disease the cortex is cut off from the thalamus (an earlier and more primitive structure) the patient will laugh and cry with great facility for no apparent reason at all.

The cerebral cortex does not just sit and think. The mass of sensory impressions that reach it have to be translated into action, and in front of the main sensation-receiving stations is a large area of nerve-cells whose axons pass down into the brain-stem (joining the spinal cord with the cerebrum) and the spinal cord. These cells initiate voluntary movement: their axons end up in the spinal cord near the nerve-cells whose axons pass out of the cord between the vertebrae to end in the muscles of the limbs.

We make a distinction between the voluntary movements of the muscles of the limbs and of the body, and the involuntary movements of the muscles of the internal organs—the stomach, intestines, bladder, heart, lungs, and so on. The voluntary muscles, which are under the control of the will, are supplied by one set of nerves, which we have so far been mainly considering; and the involuntary by another set, the sympathetic nerves and the autonomic nerves—the chief autonomic nerve is the tenth of the nerves leaving the brain. But it is important to realize that one is not conscious of the contraction of the voluntary muscles or of 'willing' *this* muscle to do *that* movement, but of the displacement of joints and of movements at joint-surfaces. You are aware of your knees bending or of your arm stretched out behind you, but not of the muscular movements that effect these attitudes.

BALANCING MECHANISMS.

Situated close to the organ of hearing (which lies deep to the outer ear) are three small semicircular canals placed in three different planes at right angles to each other. These canals communicate with each other and with two small chambers called the saccule and the utricle. Projecting into the canals are fine stiff hairs, and the canals themselves are filled with lymph. When the head moves the lymph in the canals moves also, and exerts pressure on the hairs. The bending of the hairs stimulates the nerve-fibres in close contact with them, and the nerve impulses thus set up travel to various parts of the brain, giving the brain information about the position of the head. In the saccule and utricle are minute 'stones' or calcareous particles. When the position of the head is altered these little stones stimulate hair cells; this stimulation also is handed on to nerve-fibres, which carry information to the brain as to the altered position. The semicircular canals and the saccule and utricle also subserve reflex mechanisms for maintaining the head in an upright position, and for the adjustment of the position of the body in relation to that of the head in space.

THE CEREBELLUM.

The nerves from this balancing mechanism have important communications with the cerebral hemispheres, with nerve-centres controlling the movements of the eyes, and with the cerebellum. The cerebellum is a mass of nerve-tissue (in shape rather like a wart) situated behind the cerebral hemispheres and attached by bands of nerve-fibres which enter the brain-stem. The functions of the cerebellum are not very exactly known, but it seems clear that it influences 'muscle-tone.' Space does not permit a discussion of this important question of tone. Muscle-tone is a reflex contraction of muscle. It is a taking-in of the slack, a continued slight tension. This tone imparts the firmness to muscle which is always present even when the muscle is not executing a movement. Tone enables posture and position to be maintained: in its absence we should go 'all of a heap.' It is a reflex activity which depends upon sensory stimuli from the muscles themselves, and, to a less extent, from the eyes and the balancing mechanism in the ear, acting upon various centres of nerve-cells in the spinal cord and the brain-stem.

The cerebellum also appears to exercise some guiding control over the cerebral hemispheres in the carrying out of voluntary movements; for in disease of the cerebellum there is considerable disturbance of voluntary movement—a clumsiness and lack of co-ordination of muscles —and of balancing power.

THE INVOLUNTARY OR AUTONOMIC NERVOUS SYSTEM.

Brief reference has already been made to sympathetic and autonomic nerves. These names are rather confusing, but this group of nerve-cells and fibres (neurones) is concerned with involuntary muscle and the involuntary secretion of glands. Involuntary muscle is present in the heart, stomach, and intestines, lungs, blood-vessels, bladder, etc., and is beyond the control of the will. The activity of these organs is automatically regulated. It would be dangerous for them to come under the tyranny of the will, for they must work consistently and constantly; although there is no doubt that their efficient working is upset by emotional disturbances. These nerves are divided into two main groups, whose action is mutually antagonistic on the organs which they both supply. For example, the sympathetic nerves quicken the rate of the heart while the vagus nerve (an autonomic nerve) slows it down. The sympathetic nerves immobilize the muscles of the stomach and intestines while the vagus nerve causes them to contract. It has already been pointed out that the sympathetic nerves, when stimulated, produce the physical changes of rage and fear.

This involuntary nervous system has an important and essential

part to play in the control of blood-pressure and the heart-beat, of respiration, of movements of the alimentary tract and of digestion. In connection with these functions various important reflex centres exist in the brain-stem.

Summary

In this brief outline of the nervous system, condensation has been inevitable. It is important, however, to grasp the fact that the nervous system is not a collection of 'centres,' each looking after its own concerns, but is an integrating and co-ordinating mechanism whereby all the sensory impressions impinging on the body from within and from without are turned to harmonious action for the benefit of the body. No mention has here been made of the brain as an organ of mind: we have kept to known physiological facts.

IX—THE MIND

It has long been assumed that the human body is a kind of self-regulating machine. It is only just beginning to be suspected that the mind is just as much a machine as is the body; in the sense that it is a part of the ordinary world in which everything has a cause. The happenings which go on in the mind are such things as thoughts, feelings, and wishes: of these we have immediate knowledge in so far as they are our own; other people's mental processes are inferred by us from their behaviour. Thus the mind can either be studied by watching our own thought-processes (this is known as introspection), or it can be studied by watching the behaviour of other people. These two ways of looking at the mind produce somewhat different pictures, but it is generally believed that the mechanism which we study is the same in both cases. If we look at a motor car from the outside, a different impression is obtained from that made if we are seated within the car, and examining the controls: the essential mechanism, however, is the same.

Three Mental Processes

It is customary to divide the activity of the mind into three components—thinking, feeling, and willing. By the word 'willing' we mean the desires, impulses, and wishes which cause us to act. These mental processes are not entirely separate, but the division is a convenient one. The mind can be regarded as a sort of controlling agency of the body: the more highly organized the animal body the more complex the mind will have to be. In the lower forms of life we discover merely simple reactions, such as moving away from a noxious object in the vicinity. Some plants and lower animals are so simply co-ordinated that they can be cut in pieces and yet each segment will grow and live as an individual. The mind necessary for such forms of life must be a very simple one, and cannot have the same centralized unitary nature as our own. The development of mind in the course of evolution is coincident with the development of the nervous system and, as the animal becomes more and more of a unit, the nervous system is found to be correspondingly more complex. This system reaches its highest development in man, and its centre is the brain, which is closely associated with the co-ordinating process which we term the mind.

The rules by which the mind works and the causes of thoughts and feelings are beginning to be understood, but, at present, there are big gaps in our knowledge. At the same time these gaps are mainly concerned with the details, and the general outlines of the mental processes can be described. Of the three types of processes which we mentioned earlier, the most important is that concerned with wishing and with acting in accordance with these desires. The desires are the driving force of the machine. Without these fundamental desires there would probably be no thinking and no feeling. All desires and wishes spring ultimately from inherent tendencies or modes of behaviour known as instincts. We will therefore first of all consider the nature of these inherent tendencies.

Man is an animal, and he shares with other animals two fundamental necessities. These necessities are to safeguard his own existence (by obtaining adequate food and keeping off enemies) and to perpetuate his kind in the form of offspring. There are also subsidiary necessities, such as the need for acquisition and storage of food and the need for suitable care of the offspring while they are unable to care for themselves. Squirrels store nuts so as to have food for the winter, birds gather sticks and build nests in which to lay their eggs, and the higher animals feed and guard their young for months and even years. The instincts are developed in order to meet all these needs. If we consider the first group of impulses—the instincts of self-preservation, as they have been called—we shall find they involve hunger as the most important item. This desire to assimilate food is closely related to destructive and aggressive impulses: it may be necessary for the animal to hunt, to fight, and to destroy in order to obtain its food. The impulse of self-assertiveness is probably derived from the same source.

An animal will not survive unless its aggressive impulses are strong enough to enable it to obtain what is necessary and to defend itself from its enemies. The impulses which are directed towards the preservation of the race of which the individual is a member are known as the sexual instincts. It is obviously just as important to a race of animals for these instincts to be strong as for those of self-preservation—possibly much more important. While the hunger group of instincts are associated with aggressiveness and self-assertion, the sexual instincts are of a more altruistic character. They are directed towards the preservation of persons other than the self, and the actions which they promote are characterized by feelings of love and tenderness towards other persons. To some extent these two main groups of instincts conflict with one another in the individual, but, normally, a state of equilibrium is obtained. When a male animal fights with its rival for the possession of a female the aggressive impulses and the sexual impulses are both aroused and work together harmoniously for the same end. A similarly

effective mixture of impulses occurs when a lioness defends her cubs. This capacity of impulses of different kinds to mix with one another, giving rise to an effective resultant activity, is a fundamental characteristic of the mind. As we conduct our ordinary lives we are not usually aware of the violent forces inside us. This is because, in the course of evolution and individual development, the conflicting impulses have been so perfectly balanced that we are not conscious of them. When we say that impulses are repressed, this is what we mean: thus, repression is a perfectly normal and necessary process. It is probable that the race-preservative impulses must predominate in order to produce a civilized community, and many psychologists hold that the main motive power of all our social life depends upon them. Normally, our aggressive impulses are largely repressed, and we are enabled to entertain friendly feelings even for our enemies.

When we come to the consideration of the other two great divisions of the mind, feeling and thinking, we can detect the underlying instinctive forces, though sometimes it is not easy to perceive exactly of what type they are. With regard to feeling, the most important 'modes,' as they are termed, are pleasure and pain. Pleasure and pain are closely related to the instinctive forces and, roughly speaking, while pleasure is associated with the satisfaction of a desire, pain is associated with events which are antagonistic to its fulfilment.

In the ordinary sensations of touch, vision, taste, and so on, we may not often detect the impulses which are brought into play, and so enable us to appreciate the meaning of the sensations. This is again due to the fact that we are highly complicated organisms. Similarly, with regard to thinking, which must include imagining and day-dreaming, as well as consecutive trains of thought, the desires which are causing us to make certain efforts, or to be presented with this or that idea, are not immediately apparent. Our dreams at night are brought about, to a large extent, by impulses which have been repressed and have not been satisfied during the day. But even in dreams the true wishes which lie behind them are not discernible without painstaking analysis. In fact, we hardly ever know what our real motives are. The forces which drive us are so poised that we can only think clearly when we are unaware of the reason why we think. Under the influence of overmastering passion we do not behave in the most logical manner. As with our social activities, so with our thoughts and our constructive abilities, it is probably necessary that the instincts of race-preservation should have a slight preponderance over those of self-interest. In the words of St. Paul: 'If I speak with the tongues of men and of angels, but have not love, I am become sounding brass or a clanging cymbal.' We shall see, when we come to the discussion of mental abnormality how very important this principle is.

The Working of the Mind

We will now turn to the question of how the mind is kept in a healthy state. From what has been said already, we know that a person's actions are determined by basic impulses of the crude animal type which are combined together and adjusted to produce delicate and fine reactions. This way of harnessing the instincts has been termed 'sublimation,' and our ordinary everyday activities, or what we call our work, are instances of sublimation. It must be remembered that the instincts do not lose their force in this proceeding, it is only that they are properly harmonized. It is just as serious a matter for a man, who is accustomed to a certain type of work, suddenly to have to change it as it is for him to go hungry. Psychologists have noticed, even, that certain people who are accustomed to work in an office all the week and who, during that time, are efficient and cheerful, become sullen and bad-tempered for no apparent reason on Sundays. On the other hand, it is equally important that time should be available for the recuperation of energy in order to obviate fatigue and boredom. Recently a great deal of experimental work has been done on the question of how the mental apparatus works best. It appears that, in some types of occupation, a maximum efficiency is obtained and, after that, there is a slow decline unless some new factor, adding interest, enters into the work. There is a curious relationship between fatigue and boredom. When a person is presented with a new problem or a new technique which he has to learn, first of all there is an improvement in his ability, and this improvement may even accelerate at the beginning. Soon, however, the rate of improvement begins to decrease and, finally, a level is obtained beyond which the individual does not seem able to advance. Then, after a time, boredom may set in, and the results will deteriorate. If the problem is changed, however, the same type of improvement will start all over again. It has been shown by physiologists that neither the nerves nor the muscles themselves are at all easily fatigued, so that deterioration, or lack of improvement, in work of a monotonous character is usually not due to fatigue at all, but to boredom. That is to say, the direction of the basic impulses begins to wander and they are diverted into other channels. Different people vary very much in what constitutes monotony for them. To some people the repetition of the same type of behaviour may be an obsession, but this is an abnormality. Actually a periodic change in occupation is essential for the highest efficiency. This is why we have Sundays and other holidays; and to neglect opportunities for obtaining recreation or changes in surroundings will, sooner or later, lead to boredom in work.

What has been said regarding work applies also to play, and perhaps it is easier to understand in this connection. In games the primary

impulses are less hidden than in many other social activities. The game, in fact, is the earliest form of sublimation. In its primitive form it occurs naturally in the behaviour of the young of all the higher animals. The balance of different types of impulse, which is obtained in an occupation like football, is comparatively easy to detect. Here the player, for the time being, loves his own side and hates the opponents. The hatred, however, is not allowed to overstep well-defined boundaries and, in order to obtain the commendation of the spectators which is necessary to his own self-esteem, the player obeys these rules of the game. In this way his pride and his aggressive impulses are balanced against his friendly and altruistic feelings towards the members of his own side, with whom he is able to indulge in an obedient admiration for the captain. All these instinctive desires are satisfied at the same time by the game. Perhaps one of the reasons for the popularity of games lies in the very fact that they are a much less complex method of reacting to the fundamental driving forces of the mind than such things as office, factory, or house, work. Recreation, therefore, is just as much a method of reacting to fundamental impulses as is everyday work. The staleness of which players and athletes complain during a prolonged period of training is again usually an instance of boredom and not of fatigue, and it is an indication that a temporary change of occupation is needed.

The Development of the Mind

We have not yet touched on the question of how the mind develops in the individual. The newborn baby has practically no mind: it only has the primitive instinct of self-preservation, and this causes it to make sucking movements when placed at its mother's breast, and to cry if it is hungry. During the course of its growth to adult life it will acquire modes of behaviour: its instincts, as well as the rest of its mental apparatus, have to be developed step by step. How does this development take place? The psychologists a hundred years or more ago had already enunciated what was known as the law of association. This law of the mind means, roughly, that any two happenings which are perceived or felt at the same time, or any two thoughts which arise simultaneously, become afterwards associated with one another so that the memory of one recalls the memory of the other. James Mill and other English writers of the time were able to give a fairly plausible description of the development of mental activities such as language, the use of numbers, and so on, by using this principle as a working rule. More recently, scientists have carried out experimental investigations the results of which are much more convincing than the theorizing of the older psychologists. As we saw, the Russian physiologist, Pavlov, has

shown that dogs learn quite automatically to associate experiences which occur simultaneously. In Germany, Koffka has made similar experiments on the methods of learning of monkeys; and in America, Watson showed that young children and even adults form their associations in the same way. The laws of association, or the laws of conditioned responses, as they are known to the experimentalists, are now well established, and this accounts for the process of learning which the individual undergoes in the course of development from the infant to the adult.

We may look on the laws as governing either thought or behaviour, but, from whichever point of view we look at them, one striking fact emerges. The psychologists noticed that associations were most readily formed when the mind was in a state of alertness or attention. Pavlov found that his dogs would only learn when they were under the influence of hunger and also in a friendly mood. This means that the driving force of some instinct is necessary in order that learning shall take place. In fact, the whole development of mind is moulded so as to be of service in the satisfaction of the essential animal instincts. In the case of the child the development of its instincts is very complex. In the earliest stages its dependence upon its parents, particularly upon the mother, is complete; and the importance of the parents in determining the way in which the child develops cannot be overrated. In studying the mental illnesses, the Viennese professor, Freud, found that he could trace most of the important associations connected with these disturbances to very early life. He originally suggested that nearly the whole basis of mental development was laid down before the age of five years: subsequently the ages between one and three years have been regarded as the most important. It is quite reasonable to suppose that in these early years, when the mind is growing most rapidly, the most important types of reaction are laid down. These early mental structures will last the individual the whole of his life, and will form the outline pattern into which subsequent associations will be fitted. It is difficult for an adult to imagine the awe with which a child views its parents and other grown-up people with whom it comes into contact. These persons it regards as infallible, and it feels instinctively that they have its interests at heart. A sudden change of attitude on the part of a person who is in a position of authority over a young child, or inconsistencies in behaviour, may lead to conflicts in the child's mental development, and cause serious disturbances later on. Unfortunately we do not yet know sufficient about the formation of the mind in young children to be certain what types of action on the part of parents are always best from this point of view. Many of the actions of parents, such as punishments, for example, which may harm the children are done with the best intentions. Since the parents are unaware of their

own fundamental impulses, the best-motivated actions may even be the most harmful. It is difficult to realize how deeply a child feels when it is put into disgrace or punished. On the other hand, certain kinds of discipline may be helpful to the child in after life, and opinions differ widely as to the best methods of moral education. We can, however, be certain of some general principles.

The most important of these is that the child should be treated fairly, and without gross inconsistency. It should not be praised one day for doing something for which it is punished the next day. Perhaps we can draw an analogy with the nutrition which is necessary for the proper growth of the body; the growing mind also needs nourishment. While there are essentials known as vitamins in the nourishment of the growing child, so there are essentials in the mental sphere. The child is very dependent upon adults, and it requires to be assured by the way in which they behave that the adults are willing to supply the love and interest which it needs. The child, brought up, from early years, in surroundings where adults are antagonistic, develops a one-sided or anti-social character. Its mind has been starved of the essentials, even if it has been crammed with learning. A great deal of the growth of the mind takes place simply by copying the reactions of other people, and the child unconsciously copies the actions and imbibes the outlook of people with whom it is brought up. Thus, a child brought up by inconsiderate or cruel people may copy them and develop the same mentality. This pliability of young children is sometimes known as suggestibility. While children are normally suggestible, suggestion also plays its part with adults. An adult who is unduly receptive in this way is incompletely developed. We shall see, when we come to the study of mental disorders, that incomplete development is very common, and is one of the most potent causes of later troubles. It therefore behoves the parents to encourage children to think for themselves rather than to obey implicitly and, as far as possible, to give reasons rather than orders. Children should not, for example, be stuffed up with lies about sexual matters. Such behaviour tends to inhibit the proper development of the powers of thinking and feeling.

While these principles are useful in procuring the mental health of children, and for preventing troubles later on, the most valuable test of mental health in a child is whether or not it is happy. A child who is happy and seems to be at ease with its surroundings cannot be mentally ill. In view of the difficulty of curing mental disorders in later life the careful attention to the needs of the minds of young children cannot be too strongly urged.

Life is a cycle, and birth is but the commencement of a journey which continues through youth, maturity, and old age, to end in death. To ensure the continuance of the species, Nature is most ingenious and prolific in her reproductive efforts. The lowest forms of life consist of but one single cell, and reproduction is effected by binary fission. The cell merely divides into two parts, which in turn increase in size and, under favourable circumstances, themselves divide in a similar manner some twenty minutes later. A simple calculation shows that if this process proceeded unchecked a single bacterium would, within the space of twenty-four hours, be the parent of a billion daughter bacteria; so that, if other factors did not intervene, it is evident that the whole world would soon be filled with living germs. In point of fact, lack of available food and the toxins extruded by the dead bacteria serve to control their numbers. The laws of over-production and the struggle for existence, first enunciated by Malthus and Darwin, apply to all living things. It has been estimated, for instance, that if all the offspring of a single pair of thrushes survived and mated there would within twenty years be so many billions of thrushes in the world that there would not be room enough on the earth's surface to contain them, even if they stood in rows touching each other. Similarly, if the normal reproduction of herrings proceeded unchecked, then within five years the sea would be a solid block of this prolific fish.

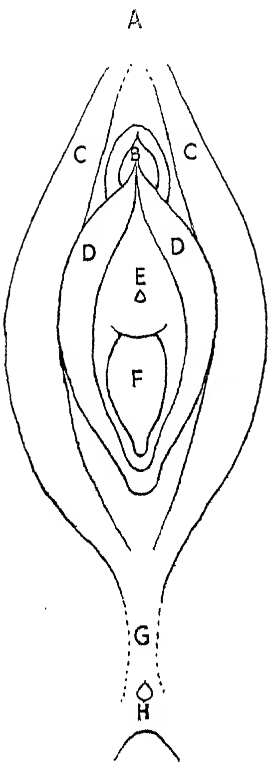


DIAGRAM OF THE FEMALE EXTERNAL GENITAL ORGANS

A. Mons Veneris; B. Clitoris; C. Labia Majora; D. Labia Minora; E. Urethral Orifice; F. Vaginal Orifice; G. Perineum; H. Anus

The single cell, of which the lowliest forms of life consist, performs all the functions necessary to life. Man, at the other end of the scale, is made up of thousands of millions of cells. His brain alone contains

some twelve thousand million cells, while his red blood corpuscles, which represent less than one-twentieth of his body weight, would, if placed touching each other in a line, stretch right round the coast of Great Britain. Nevertheless, every living thing develops from a single cell, and to this law there is no exception.

Sexual Reproduction

The lowest forms of life reproduce themselves asexually, but very early as we ascend the scale of the vegetable, as of the animal, world, sexual reproduction becomes the rule. The essence of sexual repro-

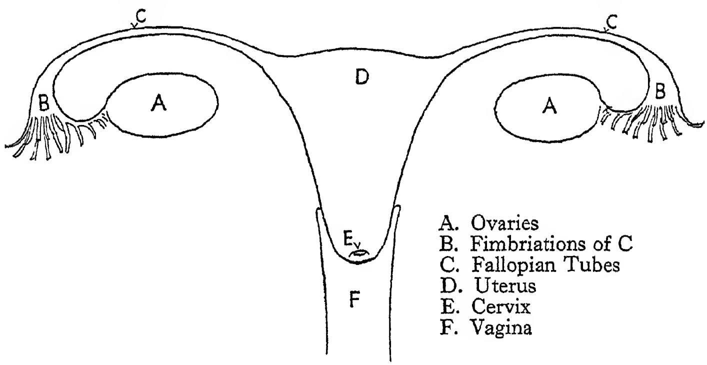


DIAGRAM OF THE FEMALE INTERNAL GENITAL ORGANS

duction is that the cell from which the animal or plant develops is enriched by the transference of material from another specialized cell, a process termed fertilization. The fertilized ovum then keeps on dividing, until the particular form of life is mature. In between the stage of simple division and that of sexual reproduction, an intermediate process, a form of budding, may be observed. Two cells approach each other, and material from the one buds into the other. This, although strictly asexual, is essentially an example of the principle which the sexual process is designed to perfect. Some simple forms of life, such as the parasite which causes malarial fever, have two ways of reproducing themselves, one sexual and the other asexual; but with them asexual reproduction cannot continue indefinitely. Fertilization, or the transference of material from the male to the female, must occur at intervals, failing which the parasites die. It is impossible to offer a satisfactory explanation of why fertilization is essential to the reproduction of higher organisms, but the fact is that neither life nor reproduction can be fully explained in terms of physics or chemistry.

It has been stated that, just as one bacterium can give rise to a prodigious number of daughter bacteria, the fertilized ovum from which man develops similarly gives rise to thousands of millions of cells. Except, however, from the numerical standpoint, the processes are entirely distinct. The bacteria are all identical, whereas the cells into which the fertilized ovum divides consist of many and varied types. If, for instance, a minute portion of the eye of the chick embryo be

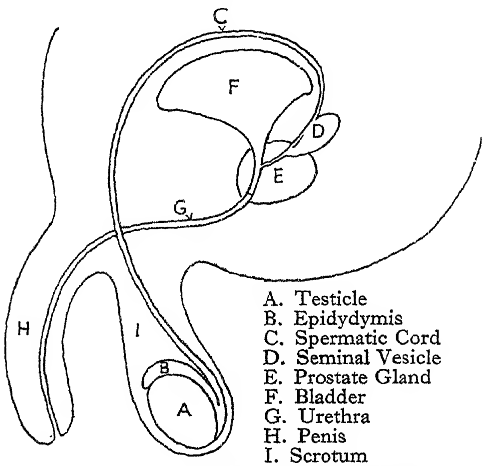


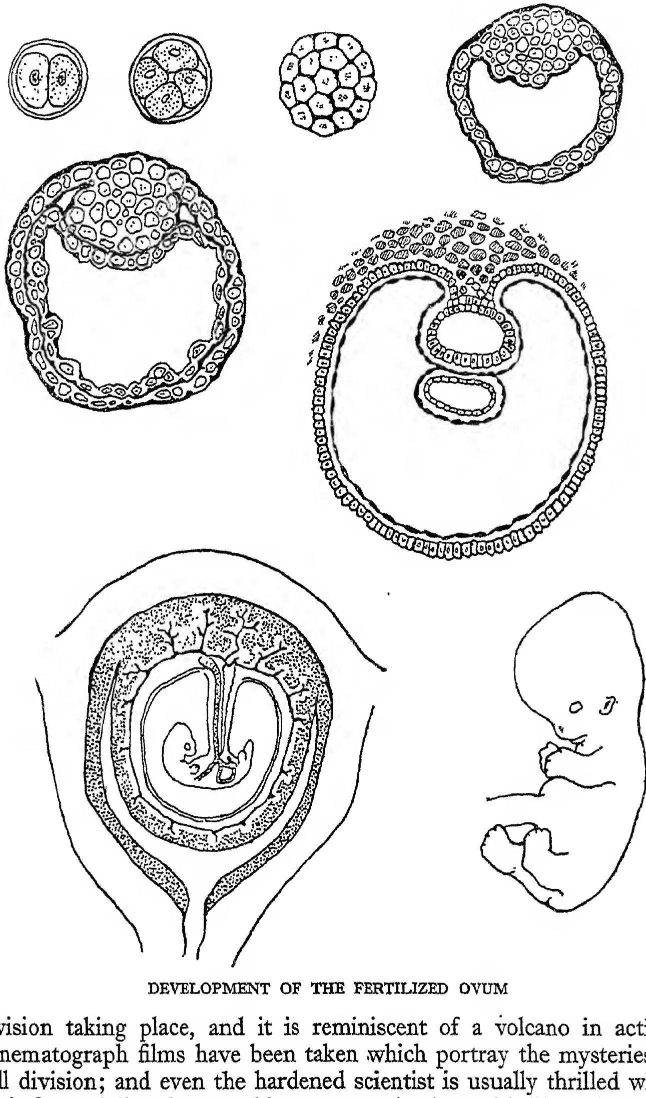
DIAGRAM OF THE MALE GENITAL ORGANS

removed from the egg with a fine needle and placed on a suitable medium, something resembling an eye will develop. This process, termed tissue culture, shows that in the early stages of division certain cells are formed which have the inherent power to develop along certain lines, some into brain, some into muscle, some into bone, and so on; and that this power is retained to a marked degree even when they are removed from the rest of the embryo.

CELLULAR DIVISION.

Further, the division of each cell into two parts is a very elaborate and profoundly fascinating process. A cell consists of protoplasm, or living matter, which contains a nucleus and a nucleolus, two small collections of highly specialized protoplasm which govern and control the cell. The nucleus contains several 'threads' or chromosomes, the number of which for each species is constant in every cell. These chromosomes are of the most profound significance, and will be referred to later; but here the thing to note is that each of the two resultant

cells is furnished with an exactly equal amount of chromosome material. It is possible by the aid of powerful optical instruments to watch this



DEVELOPMENT OF THE FERTILIZED OVUM

division taking place, and it is reminiscent of a volcano in action. Cinematograph films have been taken which portray the mysteries of cell division; and even the hardened scientist is usually thrilled when he is first privileged to see this process so instinct with life and energy,

and realizes that the dividing cell was derived from a cell which could trace its parentage back perhaps for millions of years.

THE CHROMOSOMES.

It has been asserted that the chromosomes in the nucleus of the fertilized ovum are of the most profound significance. Whether a particular ovum develops into a chick, a rat, a horse, a cow, a Chinese, or an Englishman, is largely determined by the chromosomes. On them depend not only the shape and configuration of the plant or animal, but also the character. The hereditary characteristics, good and bad, and some of the physical defects, of all the men and women living in England to-day were at one time 'contained' in chromosomes, the whole of which could have been placed with ease into an ordinary matchbox.

The egg of a hen or other bird contains in its yolk a minute ovum, which can be seen by means of a suitable lens. Both the yolk and the white of the egg are designed merely to provide food for the growing embryo. The shell is porous, and through it the developing chick 'breathes.' All birds and some reptiles lay eggs which are hatched either by the warmth of the body or the heat of the sun, but in no case will development take place unless the egg was fertilized before it was laid. In mammals such as the horse and dog, and including man, the ovum, which is of the same order of size as that of the chicken, is not provided with a large amount of nourishment, but obtains its food supply from the mother's blood. Development occurs in the uterus or womb. The mother's blood does not pass directly into the foetus, but the requisite nourishment is filtered through a membrane folded into hundreds of thousands of folds, and contained in the placenta or after-birth.

REPRODUCTION IN MAN.

It is now possible to consider the main facts concerning reproduction as it occurs in man. The important cells are the ovum and the spermatozoon. The ova are contained in two organs called ovaries, which are situated one on either side of the pelvis. In size and shape these roughly resemble a large brazil-nut. When a female child is born each of her minute ovaries contains about a hundred thousand ova, but by the time she reaches puberty this number has considerably decreased. From then on, at least one ovum ripens each month, and escapes from the ovary into one of the two fallopian tubes which lead into the uterus. The neck of the womb passes out into the top of the vagina, or front passage. It follows that the inside of the uterus is in direct communication both with the peritoneal cavity and with the outside of the

body, a very important fact. If the ovum becomes fertilized it embeds itself in the lining of the uterus, establishes its own blood supply through the placenta, and develops until the child is ready to be born.

The spermatozoon, or male reproductive cell, develops in the testes, of which there are two in the purse-like structure which hangs between the thighs, known as the scrotum. During coitus or sexual intercourse millions of spermatozoa are ejected into the vagina. They possess tails by which they travel into the neck of the womb and up the uterus to meet the ovum in one of the fallopian tubes. Only one spermatozoon pierces and enters the ovum. The fertilized ovum possesses the requisite number of chromosomes, half of which derive from the male and half from the female cell. It follows from this account that sex-appeal and sexual excitement have as their biological purpose the facilitating of the meeting of the spermatazoon with the ovum. It also follows that, whereas with the male the function of reproduction would appear to be something almost extraneous to his ordinary activities, woman is peculiarly constructed to conceive, bear, and suckle children.

The testes and the ovaries, in addition to their germ-cell activities, elaborate 'internal secretions' which are largely responsible for determining the secondary male and female characteristics. Each man, however, contains a certain amount of the feminine, and each woman a certain amount of the masculine in their make-up; whilst, in extreme cases, the man may be very 'effeminate,' and the woman exceedingly 'masculine' in type. In any given society, it may be assumed that usually the most feminine women, or those biologically most successful, will be selected for marriage.

PART TWO

EVERYMAN IN HEALTH

I—HEALTH AND DISEASE

Abstractly we may look upon health as a condition of harmonic fluctuation between our several parts, bodily and mental, as well as a harmony between ourselves as a whole and the outside world, including our fellow human beings. This, as has been said, is not a static condition, but one of constant vibration and adjustment. There is a normal, to which all the functions of a healthy man tend to approximate. At every moment the pendulum swings a little, now to the right and now to the left of the centre of its arc. But the divagations are never great, and readjustment is prompt. When, through external circumstance or faulty structure, aberrancy from the normal is wider than our recuperative faculties can rectify, we have disease. The fundamental problem of the medical art consists in the recognition of the conditions or faults responsible for such aberrancy, and the discovery of the conditions most favourable for the operation of the natural healing powers of the body. Sometimes a chemical or physical defect can be made good; sometimes a hostile force can be warded off or destroyed. Sometimes the automatic defensive mechanisms of the body can actually be supplemented; but all the time the aim of wise therapy is to restore a working balance, a sustainable harmony, even if this has to be of a kind somewhat different from that which previously obtained.

But an adequate concept of health includes more than the existence of an almost passive harmony. It implies the making the most of ourselves and realizing the best of which we are capable. The word itself signifies wholeness or haleness, and is probably synonymous with holiness. The concept of health which has become current in recent times is far too narrow. With the progress of the medical art disease has assumed increasing importance in human thought; and by disease has commonly been meant the existence of one or the other of those recognizable syndromes, or collections, of unpleasant symptoms to which, by reason of their recurrent similarity, specific names have been applied. Health has come to mean, in common talk, an absence of each and all of these several forms of disorder. This negative attitude to health is numbing to vitality. The conception is a passive one; the reality is an active one. The truly healthy man is courageous, not one in hiding, even though his skin be still intact. He looks hopefully forward, not timorously behind him; he is resilient, not

static; he is enthusiastic, not merely enduring; his body and mind are one, collaborators in an enterprise pleasurably exciting. Smooth sailing is not expected; and, when necessary, the decks can be cleared for action in a fraction of time. Fear takes its proper emergency station; hope, interest, and eagerness inform his acts and thoughts; prudence is suffused with faith; the body is cared for by the mind, and the mind is tended by the body.

This general picture of health and of the healthy man must not be taken to imply the non-existence of specific dangers and specific enemies, calling for methods of defence and resistance equally specific. To some extent man, in common with other animals, is equipped with protective weapons, operative without the intervention of his intellect and his conscious will; but our species would appear to have an endowment shared but in small degree, if at all, by the rest of the animal creation. We have the strange power of contemplating and analysing the circumstances that environ us, and of devising means differing from a thing 'naturally' existing whereby these circumstances may be modified or countered to our advantage. Man has invented houses and clothing and fires; he has invented cooking; he has created instruments whereby he can see the hitherto unseen, and an apparatus enabling him to convert into audible sound ethereal vibrations of the existence of which our ancestors had no suspicion.

The old view that the entire universe, or at any rate that this world and all its creatures and component parts were created to satisfy the needs and tastes of man, to which so many of them do, indeed, minister, has largely given place to a converse conception. Anatomists and physiologists have striven to discover and to demonstrate the purposefulness of all our structures and all our functions—the popular assumption being that man, if he would but live 'naturally,' has been specially and perfectly built to fit the world as he finds it. The profundities of what we may call universal psychology are, of course, too deep for our comprehension; but, so far as the observable facts go, we cannot justly say that there is much more evidence or much less evidence for one of these concepts than for the other. The very fact of man's continued existence in the world over hundreds of thousands of years implies a considerable measure of compatibility between man and his environment. But the harmony is not perfect, and little more than a temporary working compromise is possible. Disease and death would seem to be unavoidable features of man's earthly career, in spite of all our efforts—not entirely unsuccessful—to lessen the one and to postpone the other. Wonderful as is the chemico-physical—to say nothing of the psychological—mechanism of the human body, it is fair to say that, even measured by our engineering and scientific standards, scarcely a single bit of our machinery is really perfect.

Nor need we dwell on mere limitations, such as those which restrict our range of vision, of hearing, and of feeling; in almost every part of our body we find structures, rudimentary or otherwise, unfitted for use in the sort of life man lives and the posture he has adopted. The study of other animals forces us to the conclusion that many of these useless parts are but the decadent vestigial remnants of organs that may well have had value to man's pre-human ancestors living quite different kinds of lives and adopting quite other postures. The in-turned tail which forms the lowest part of our spine is a good example of such useless vestigial structures. Dozens of other illustrations might be adduced. In some cases these structures, once purposeful and useful to animals walking on four feet, have been to some extent modified and adapted so as to have a sort of makeshift utility in situations for which they are not specially fitted. But, in many cases, no such adaptation has taken place; and these remnants or leavings are nothing but a source of additional danger and difficulty to their possessors. It is probable that the vermiform appendix is such a useless and dangerous vestige.

Consider, again, our natural defences against bacterial and other sinister enemies. Against minor attacks of many common germs our cells automatically put up an effective defence. But confronted by other microscopic enemies, they seem powerless. The most seemingly vigorous man, living what we call a perfectly healthy life, is as likely as is the weakliest or the most debauched to fall victim to pneumonia, to yellow fever, to malaria, or to cancer. It would seem, therefore, to be idle to preach the doctrine that by 'returning to nature' man can escape disease and all risk of hygienic disaster. Equally foolish is it to deride as unnecessary and useless the work of the physiologists and of those who have striven and are striving to create a scientific—and therefore an artificial—system of medicine and health culture.

II—HEREDITY AND ENVIRONMENT

When we hear of the arrival of a new baby we do not ask: 'What is he like?' for we know that he will be very like any other baby. We are more apt to ask: 'Who is he like?' We know that definite family resemblances are to be expected. There may be a strong resemblance to one or other parent, or the child may seem to be a blend of both, and this does not seem strange. We may find more difficult to understand, however, the repetition which one often finds in a child of some feature which is not traceable in either parent, but is familiar to us in one of the grandparents, or even in a distant relative on some collateral branch of the same stock. If we believe that these recurring features cannot be merely fortuitous, we are recognizing the main principle of heredity. We are children of the past, and we carry in our physical and mental make-up much that was transmitted to us by our parents, not from themselves only, but from the generations which preceded them.

Although the baby may be 'the image of its father,' it is by no means a replica. It is an individual, as are we all—so like our fellows, and yet so different. In the practice of medicine, and even in the application of general hygienic principles, we can never lose sight of the differences between individuals. It is, therefore, well worth while to devote a little time to the consideration of certain factors which control our resemblances and our variations.

These factors fall under three main headings: Heredity, Environment, and Function. Under Heredity we include only those things which have been transmitted concretely through the parents. We must not confuse with this the legacy which we all receive, by external means, of tradition and accumulated human knowledge and experience. Environment covers all the forces which act on us from our surroundings—the air we breathe, sunlight, nutriment, and a hundred others. These two factors, our nature and our nurture, are quite separate but entirely interdependent. Environment cannot develop anything of which the potentialities were not there at the start. Nature only provides the elements for development by suitable nurture. The third factor, Function, is possibly only a part of environment. Under this heading we include the effects of use or disuse on various specialized parts of our bodies.

Fertilization

In considering heredity and environment, we must never forget the moment at which the life of the individual begins. At birth the infant

has already been developing for nine months under the influence of its environment. It is a sheltered and specialized environment certainly, and less variable than later, but it is to some extent different in each case. As explained in the chapter on Reproduction, individual life starts when the minute egg-cell of the female is penetrated by the active but still more minute sperm-cell of the male, and fertilized by it. This fertilized egg-cell must contain all the qualities, or all the possibilities, which we can ascribe to heredity.

The germ-cell of the female, the egg-cell, is comparatively large (one one-hundred-and-twenty-fifth of an inch in diameter). It has a definite envelope, a nucleus, and a good deal of cytoplasm. It probably carries a good deal of reserve matter which is used for subsistence during the period in which it is free within the body, and in the early stages after fertilization. The nucleus contains a meshwork of material called chromatin, which divides, when the cell is mature, into a definite number of bodies called chromosomes. This number is constant in every body-cell of the particular species. At the final cell division before the liberation of the ripe germ-cell the number of chromosomes is reduced to half, the chromosomes uniting in pairs before division.

The male germ-cell, or spermatozoon, is infinitely smaller than the egg-cell, perhaps one hundred-thousandth of the size. It carries little reserve matter for its brief journey. It consists of a head, which is largely composed of the nucleus, and a motile tail of cytoplasm, which propels the head against the downward currents which it encounters. In the spermatozoon, also, the number of chromosomes is reduced by half at the final division before maturity.

When one of the countless spermatozoa comes in contact with the egg-cell it penetrates the outer covering. The covering becomes hardened, excluding other spermatozoa, and the process of fertilization has begun.

There are two main results of fertilization. In the first place the nuclei of the male and female germ-cells become fused. The chromosomes do not merge, but come into intimate and orderly union, and the fertilized egg-cell thus contains the number of chromosomes normal to all cells of the species. If we believe, as we must, that the chromosomes are the vehicles of all the hereditary qualities, then the cell contains all the elements of a dual inheritance. Fertilization gives, in the second place, the impetus which starts the process of development. The chromosomes split and the cell divides, and an infinite series of redivisions follows. The embryo begins to take shape, and the specialization of various groups of cells makes possible the formation of the tissues and organs of the body.

PARTHENOGENESIS.

It is of interest to note that in a few isolated species among the lower animals an egg-cell develops into a living animal without fertilization, a process known as parthenogenesis. A similar result has been brought about artificially in certain types where it does not normally occur. Thus Delage contrived, by providing a suitable stimulus and then an appropriate environment, to rear from the unfertilized egg of a sea-urchin a sea-urchin which developed to the adult stage, and lived for three years. This is important, as it suggests that in sexual reproduction each of the germ-cells contains the essentials for development. We must accept this view if we are to try to understand how one character may be obviously of paternal origin, and another equally clearly derived from the mother. Only one of the two possible characters will be expressed in the offspring, but the dual possibilities give infinite chances of variation. In parthenogenesis there can be only one inheritance, and there seems to be evidence to suggest that the ultimate tendency is to degeneration.

THE CHROMOSOMES AND HEREDITY.

Everything that is transmitted to us directly must in some way be contained in either the male or the female germ-cell which together form the fertilized egg-cell. Of these germ-cells the most important part would seem to be the nucleus, rather than the less highly organized cytoplasm. The nuclei fuse after fertilization, but their most highly organized portions, the chromosomes, remain intact. The normal number is restored, half being paternal and half maternal in origin. The process of cell division is such that this dual representation is continued at every subsequent division, and therefore in every cell in the body. So one can hardly doubt that the chromosomes convey most if not all of our dual inheritance.

If every cell contains an equal number of chromosomes derived from each parent, then clearly the chromosomes originating in one parent, say the father, contain elements derived from his parents, and these again are derived from a preceding generation, and so back through infinite generations. The possibilities of such representation are not limited by the number of chromosomes, as parts of two chromosomes become joined at the division preceding fertilization, and this fusion occurs in each generation. Thus one chromosome might conceivably contain elements due to countless generations. Our inheritance has been called a mosaic of ancestral contributions.

There appears to be good reason to believe that in the early stages of development a portion of the original germinal material is preserved

unaltered, and that from this is derived in due course the germ-cells which give rise to the next generation. This has actually been demonstrated in many of the lower animals. For example, in the threadworm of the horse, according to Boveri, the first cleavage of the fertilized egg-cell gives rise to two cells, from one of which all the somatic or body cells are formed, from the other all the germ-cells. Weismann, one of the greatest workers in the field of heredity, maintained that in all cases the germinal material which starts an offspring is directly continuous with the germinal material from which its parents arose. He believed that there is a specific substance, which he called the germ plasm, which is borne in the chromosomes, and is the vehicle of all hereditary qualities. Germ-cells, like other cells, are subject to processes of repair and renewal, and it is on the continuity of the germ plasm, not of a series of cells, that Weismann insists. By this theory the parent is the custodian for a time of some of the germ plasm of his stock, and he may pass it on.

Galton, another of the great leaders in the field of heredity, formulated a statistical Law of Inheritance, based on a study of certain qualities, such as the stature. His conclusion was that on the average each parent contributed one-quarter of each inherited factor. Half of the remainder came from the four grandparents, and half of the other half from the great-grandparents, and so on in infinite series. Thus our inheritance is multiple, each generation back contributing on the average its definite but diminishing quota.

It is hardly possible for us to conceive the mechanism which permits the conveyance of all our hereditary qualities, through the medium of the chromosomes. Obviously only initiatives can be conveyed, potentialities which can be developed under suitable conditions, but may fail to mature or may lie dormant and be displaced by other factors. We can never forget the influence on development of environment and function, but we must not overrate it. The chick develops in the egg comparatively sheltered from external influences other than warmth, with only its hereditary outfit and the nutriment of maternal origin which the egg contains.

Some of our characters appear more fixed than others. Many are common to all human beings, unless accident or disease causes malformation or arrested development. Others are common to our race, and many of these, such as the physical characteristics of the Jew or the Negro, persist for many generations, after the original environment has been changed. Others, like the lower lip of the Hapsburgs, may be characteristic of a family, while others again are less constant. It would seem probably that our more fixed characters are those which are represented in the contributions from all or most of our sources of inheritance.

MENDEL.

Interesting light has been thrown on the mechanism of dual inheritance of characters by the work of Mendel, an Austrian monk, on the hybridization of plants. He published his results in 1866, but their importance was only realized early in this century. Mendel discovered that there were certain unit-characters which were either present or absent, but did not blend. Thus he found that in certain varieties of peas tallness and shortness were unit-characters. Tallness he called a dominant factor, shortness a recessive factor. If a tall and a short variety were crossed, the offspring all showed the dominant character of tallness. But the recessive character was still there, for if self-fertilization of the hybrids was permitted the next generation showed a definite proportion of three dominants to one recessive. Of these, self-fertilized, one dominant bred true, as did the recessive. The other two, apparently dominants, again produced the three to one proportion. From Mendel's work we conclude that we may inherit a character from one parent rather than from the other, because it is a dominant unit-character. But we must not conclude that all characters are Mendelian unit-characters following this law. Many characters blend, whilst a few are particulate, as where a blue eye contains a patch of brown. There seems a possibility, but only a possibility, that the characters of the parent who is at the time more virile will tend to predominate. From Mendel's work we can also realize that a character not expressed may be passed on, and that it may keep cropping up in succeeding generations—although by careful breeding an undesirable character can sometimes be eliminated.

Hereditary Tendencies

There are two great hereditary tendencies, one towards stabilization, the other towards variation. Our more fixed characters prevent undue variation. Our dual inheritance increases our ancestry, and thus our chances of normality. It may cancel certain tendencies or restore traits which have been eliminated. Galton's Law of Filial Regression states that children are more likely to approximate to normality in a particular direction than do their parents. There is a constant tendency to return towards the racial average. One must not take this as going against the principle of Eugenics, that the best tends to breed the best. The son of a genius need not be a genius, but he is considerably more likely to be one than is the son of a man of mediocre intellect.

There are many causes of variation in individuals. There is an infinite number of possible combinations of hereditary qualities. There may be negative variation through the losing of some element at the

first division of the chromosomes. A character may be strengthened if it is represented on both sides. The nutrition of the germ-cell may be affected by age or general ill-health.

Variation leads to Evolution. Variations are constantly recurring, and may be repeated or extended in a particular direction through the strengthening of one germinal character or the loss of another, although there is always a tendency to return sooner or later to the racial average. Darwin held that new types were evolved by a process of natural selection of continued gradual variations. The work of De Vries, however, suggests that at least a considerable part is played by mutations, sudden changes in a new direction, some of which breed true. These are presumably due to some fresh arrangement or combination of germinal elements, and it seems possible that there may be a periodic liability to change and to make experiments.

ACQUIRED CHARACTERS.

There has been much scientific controversy over the question of the inheritance of acquired characters. The question is still open, and we must content ourselves with expressing the view that it is not yet fully proved that changes wrought in the body by environment or function are ever transmitted to the offspring. Speaking generally, we do not believe that the son of a blacksmith can inherit the muscular development caused by his father's calling. He may, however, inherit the germinal tendencies to strength and good physique which made it possible for his father to become a blacksmith.

This view must colour our whole outlook on heredity and disease. Malformations and injuries due to accident are not inherited, nor are the disintegrating results of disease on the body. We may, however, inherit the tendencies or predispositions which make us more liable to develop certain diseases, and so repeat family history. These tendencies are increased by the fact that we tend to some extent to have the environments and habits of life of our parents. Thus we can account for the numerous family histories of recurring tubercular, gouty, and cardiac affections, though in tuberculosis exposure to infection plays a considerable part. Insanity is not hereditary in itself, but we may inherit the underlying nervous instability which causes the occurrence in successive generations of similar or varying mental and nervous diseases.

Certain conditions may be inherited which are not true diseases, but are defects due to the absence of a particular factor. In this class fall certain rare familial nervous diseases, colour blindness, night blindness, and haemophilia—which is a tendency to excessive bleeding, transmitted to the male through an unaffected female. Infections are never strictly hereditary, though they may be congenital, occurring before

birth. Syphilis may infect the germ-cell, tuberculosis—though rarely—the unborn child, and gonorrheal infection of the infant may occur at birth. We need not be too fatalistic about heredity and disease. We may inherit defects, or receive early infections. We may inherit instabilities or unfortunate predispositions. But variation helps—for each there is a reshuffling of the cards. We may avoid a taint, we may receive some compensation not expressed in the parent, we may overcome a predisposition by suitable environment. Transmitted taints tend to occur earlier in each generation, and so to die out.

Before turning to consider the effect of environment we may recapitulate briefly. We inherit a mosaic of ancestral tendencies and possibilities, and only what is there can be developed. But we have infinite possibilities of variation, and we are individuals not replicas. Our hereditary possibilities only become developed or expressed with suitable nurture, so there is considerable possibility of correction, and one might almost say some degree of choice.

Environment

The influence of environment comes into play from the beginning of life, the fertilization of the germ-cell. While the foetus is floating in protective fluid in its mother's womb it is only liable to damage by gross injury or pressure. It is nourished by the filtered blood of its mother, and the rapidly developing foetus is probably much more readily affected by variations in the quality of the blood than were the germ-cells in the maternal body. Although the effect of minor accidents and strains, or maternal impressions, is probably over-estimated, it is likely that acute illness of the mother, or shock and strain, sufficient to cause constitutional disturbance, may well affect development. Poor nutrition, chronic illness, overwork, or mental unrest, during pregnancy must to some extent hamper development.

During the arduous passage of the child into the world, and after birth, environmental factors become so manifold and interact so freely that one cannot hope to estimate their effect on development and health. One can only try to indicate some of the possibilities. Speaking generally, one may say that the human organism is to some extent prepared to react to environmental changes, and that it is only when these variations are abnormally great or long continued that harm may result. It is probable that minor degrees of unsuitability in environment, if long continued, are frequent causes of divergence from the best developmental path. But we are individuals, each with his personal idiosyncrasies, and what affects one may be harmless to another. Some hereditary weakness may leave us more at the mercy

of a defect in our nurture, or some strong point may make us less vulnerable than others.

There are three great worlds—the world of Inanimate Nature, the world of Living Things, and the Social World. Living beings act and react on each other continually, they are unceasingly in contact with the great forces of nature, and at every turn they are affected by the habits and traditions of society, by occupation, and by the conditions imposed by civilization. The interactions between these worlds make up our lives.

To many external conditions man is biologically attuned, and adaptation to meet their minor variations can be made without conscious effort. The force of gravity is constant. The pressure of the atmosphere on the body, and the composition of the air we breathe, are sufficiently constant to make adjustment simple. The somewhat depressant effects of humidity are compensated by succeeding spells of stimulating dryness. In the same way the changes from direct sunlight to diffused daylight, and from brisk air-movement to quiet, normally elicit simple responses of accommodation, and make possible the receipt of frequent stimulation. The regular cyclic changes of day and night coincide, in natural conditions, with our required spells of activity and rest. Only when such changes of natural or artificial external conditions are in excess can we regard them as deleterious to health.

The air contains the oxygen which is essential at every minute of our lives. The chemical processes of the body are essentially processes of combustion or oxidation. The percentage of oxygen in the air varies very little in normal circumstances, but if we breathe a vitiated atmosphere, or if the air be too damp, it is more difficult to obtain the amount of oxygen we need, and deeper breathing and harder work by the heart is necessary to get the requisite supply. The result is fatigue, and in extreme cases overstrain. We are placed in a position comparable to that of the patient whose lungs are clogged by disease so that aeration is impeded. Dust or other particles in the air also prevent free breathing, and we all know the enervating effects of a London fog. In a year of continued fog the effect on the death rate and on the incidence of respiratory complaints is very marked. An overcrowded or ill-ventilated room quickly causes depression and fatigue. The amount of air pollution may be estimated by measuring the excess of carbon dioxide over the normal, but the effects appear to be due less to this excess than to the lack of air-movement. Moving air stimulates breathing, favours evaporation, and aids the dispersal of excess of bacteria, cellular debris, and inorganic particles in the air. Wind is a natural stimulant to breathing, though we must sometimes temper the blast. Fresh air encourages secretion, preventing that drying of the mucous membranes which causes increased liability to infection.

Fresh air is beneficial, but a severe draught is not. A draught may cause undue cooling of some portion of the body, calling for excess of heat production to counteract it.

We all know the feeling of well-being engendered by a sunny day. Sunshine is not only a physical but a mental tonic, and one must never forget that contentment and mental well-being have a definite effect on our physical condition. In recent years the public have realized very fully the value of real exposure to sunlight, and there is perhaps even a tendency to overdo it. Sudden and prolonged exposure to intense sunlight will cause harmful burning, and possibly even sunstroke. One must go warily, and aim at producing bronzing rather than burning. The brown pigment gives us a protection which enables us to make use of the stimulus of sunshine without harm. In recent years it has been found that the beneficial ultra-violet rays of sunshine can be provided artificially by lamps, and so can be available at need. Again over-use has sometimes led to disappointment. Like any other tonic, sunlight can only repair a deficiency, if such exists. It has, therefore, no value in excess, or to those who have no deficiency. Sunlight is a valuable disinfectant, a killer of micro-organisms. It is essential to the building-up of green plants, on which our food supply ultimately depends. To our bodies it is an aid to metabolism, as well as a general tonic. Rickets is a disease of maldevelopment due primarily to a deficiency of Vitamin D, which appears to exercise some control over growth and development. It has been shown that sunlight has a complementary action, and that its application will to some extent counteract the vitamin deficiency. One can see, therefore, that poor lighting, like bad ventilation, in homes and workplaces, is a real danger to health, especially in large cities where fog and atmospheric pollution diminish the amount of available sunshine out-of-doors.

The sun is our natural source of warmth, but we have learnt to augment it artificially. Overheating or overclothing promotes perspiration, which should be counteracted by evaporation. If this is prevented by unsuitable clothing, bad ventilation, or an unhealthy skin, the heart must drive more blood to the skin to cool it, thus possibly causing strain and fatigue, and the withdrawal of some of the blood-supply from the brain and the internal organs. To cold we react by a reflex tightening of the skin and constriction of its blood-vessels, thus reducing the evaporating surface. Exercise will increase the body heat, but extra food is necessary to keep this up, and cold is a real danger to the ill-nourished, and to the very young or the aged, whose reactive powers are low. Civilized man will rely to some extent on protection and artificial heating, but in health we should aim as far as possible at the counteracting of temperature variations by the natural heat-regulating mechanisms of the body.

Exercise produces heat, stimulates the heart, keeps our muscles in good working order, and aids the elimination of waste products. Rest is all-important, and is the great healer. In health not only sleep but periods of relaxation are essential to compensate for times of greater physical and mental activity.

Thus we see that our bodies are well fitted to adapt themselves to the normal variations in climate and other external conditions, but that there are dangers to health and development in extremes, and in minor but cumulative deficiencies with regard to fresh air, sunlight, rest, and exercise. Civilization adds to our natural environment housing, clothing, artificial heating, and controlled ventilation, and we must have due regard to their suitability.

All through life our body processes are at the mercy of the diet which is supplied. Diet is perhaps the environmental factor which has the greatest possibilities of variation, although unless economic difficulties are too great it is the one over which we have most control. Our digestive system has certain powers of selection and rejection, and of accommodation to minor unsuitabilities of diet, but the essentials must be provided, and a bad balance may cause serious and cumulative trouble. This problem is dealt with in the chapter dealing with Nutrition, and here we need only stress the importance of diet as an environmental factor. For perfect health and proper development we require a diet containing in suitable form and proportion the necessary groups of chemical constituents. The diet must also contain a sufficient quantity of certain fresh foods to give us the small but regular supply which we require of the various vitamins or accessory food-factors. It is probable that most of us are in little danger of the acute diseases which are caused by deficiency of one or another of the vitamins, but the possibility of troubles due to minor but continued deficiencies is less remote.

Reference has been made to the importance of the hormones secreted by the ductless glands of our bodies, and to their effect on growth and development. It is possible that these internal controlling forces are affected by environmental conditions, and that disturbance of the balance of these secretions may be in some cases due to vitamin shortage, for both the vitamins and the hormones appear to act as regulators of the processes of metabolism in the body. Similarly, the absence of certain essential mineral salts, found in the same fresh foods as those which contain our vitamin supply, may affect the balance of our internal secretions.

Our occupation necessarily affects our environment, both directly and through the fact that in civilization our external conditions tend to vary a good deal with our earning power. We spend much of our lives at work, and if the occupation be too arduous for our particular

powers, or if our work is in unsuitable conditions, our health must be affected. Excess of dust, fumes, heat, or damp each bring their troubles, and lack of air and sunlight are as harmful at work as at home. Occupation affects our functions, the use or disuse of our parts or qualities. Use or education of an organ or a mental quality leads to development, while disuse may lead to deterioration.

One cannot make a silk purse out of a sow's ear. We cannot develop anything which our hereditary equipment does not supply. But suitable environment, use, and wise guidance, can do much to make the best of the available material, to encourage the good qualities, and to suppress the less desirable elements. We must not be fatalistic, for we can do much to control our health and our lives.

III—THE PERSONAL CARE OF HEALTH

Public Health

The story of Public Health administration in this country is a very creditable one. Since the Government assumed responsibility for the physical well-being of the people, as it did in the Public Health Acts of the seventies, the progress has been rapid and uninterrupted. From the Ministry of Health downwards, authorities have been constituted in county, borough, urban, and rural districts, and invested with extensive powers which, under the spirited guidance of their enlightened medical officers, have almost everywhere been fully and wisely utilized for the public benefit. Pure water, efficient drainage, disposal of refuse, wholesome milk, untainted food, are only some of the blessings which have been conferred upon this generation by progressive administrators. The plague, pestilence, and famine which our immediate forbears regarded as due to the will of an inscrutable Providence, have receded rapidly before the research work of the quiet and unassuming labourers in this field, the really great men who have completed for us the conquest of such scourges as typhus, cholera, and plague, and have shown the way to the annihilation of malaria, dysentery, black-water fever, and many another white man's bane in tropical and subtropical countries. As the result of their labours we can point at home to a diminution in the incidence and an attenuation of the virulence of many fell diseases, including tuberculosis. We have only to look at the lowered death-rate, especially among children, and the increased general longevity, to realize that the conditions of life have, in the last fifty years, improved out of all recognition. A good deal of this work has been accomplished in the teeth of the powerful opposition represented by natural conservatism and vested interests; for the gospel of public sanitation fell at first upon unreceptive ears. It is now, however, so firmly established that there is little danger of backsliding.

Personal Hygiene and Prevention

It must, unfortunately, be confessed that the progress of personal hygiene has not kept pace with these advances in public health. Scepticism and conservatism in matters of self-care are still far too general. Vast numbers of people still cling to the erroneous theories of their

forefathers in such matters as diet, clothing, fresh air, and exercise; and the task of persuading them to reform is not an easy one. Nevertheless, considerable progress has been made in the last twenty years. The Great War was instrumental in teaching at the front that cold and wet are not lethal, and at home that moderation in diet is beneficial. It is the mission of the present generation of health-reformers to carry on this good work, to explain to educated people the essentials of healthy existence, so that they may lead their animal life in such a way as to enable them more thoroughly to appreciate the things of the spirit.

Herbert Spencer, the Victorian philosopher, who died in 1903 at the age of eighty-three, taught that the preservation of health is a duty. 'Few,' he said, 'seem to realize that there is such a thing as physical morality.' This desirable attitude of mind has attained considerable popularity since his time. Far more people take an intelligent interest in matters of health than did so at the beginning of the century. From Lister's day to that time, and indeed for many years afterwards, the whole health outlook, both of the public and of the medical profession, was dominated by fear of the microbe. Disease was regarded as inevitable, a thing due to the caprice of a Puck-like Providence; and in its presence all efforts were concentrated on the search for the casual microbe and its extermination by means of antiseptics. Disease was studied, not health; not prevention, but cure; and illness was spoken of in terms of its appropriate drug. The maleficent seed was everything; the defensive soil, nothing.

We are, however, at last beginning to give due prominence to the other side of the account; we are coming to realize that, after all, man is stronger than the microbe, and that, if we cultivate the defences with which Nature has endowed us, the victory is nearly always with us. The power of the defensive endowment emerges most strikingly in all recent discoveries in medical science, whether they be in the fields of surgery or bacteriology, or in those of endocrinology or biochemistry.

SURGERY.

In surgery the work of Lister and Pasteur pointed in the direction of prevention, could their disciples but have perceived the fact. The discoveries were used, at first at any rate, to neutralize infection, not to prevent it. Prevention followed, but after a long interval. To-day, a suppurating wound is regarded as a grave reproach to the surgeon, because it means that he has failed to utilize all the means for prevention that are now so abundantly at his disposal. The recognition of prevention as the guiding principle, and its cultivation down to the minutest detail, have enabled to be employed and carried to a triumphant conclusion surgical measures which in the days of 'cures' could never have

been undertaken. This new note of the paramount importance of prevention is emphatic, even in the domain of bacteriology—the citadel of the omnipresent microbe.

BACTERIOLOGY.

The masters of this science tell us that most of the pathogenic germs—pneumococcus, diphtheria bacillus, the enteric group, and many others of less importance—are permanent residents in the tissues of perfectly healthy people; and that it is only when such people have lowered their resistance by hygienic misdeeds that the germs make a sortie against the weakened defences and give rise to disease. Most of us, when young, suffer from slight attacks of maladies which in their full efflorescence are highly dangerous; but our defences being in good order we are able to throw off with a headache, or a slight cough, or an attack of diarrhoea, an infection which in a less favourable state of our defences would have meant several weeks in bed and a prolonged convalescence. A consideration which emphasizes the importance, in the causation of disease, of the human soil as against the microbic seed, is the behaviour in the human body of a bacillus, now so well known that its name, *bacillus coli communis*, has already tripped gaily off the tongue of several generations of interested laymen. This bacillus, of which there are several types, inhabits the intestinal tract; and the predominating type is found to vary enormously with the nature of the food consumed by its host. It is not so much that the bacillus coli communis changes its type according to his diet, as that differing diets encourage different breeds to grow and predominate. Some of these breeds are our very good friends, and our ready helps in defeating our enemies of the putrefactive kinds. Thus, it is evident that not only will a suitable soil defeat enemy germs by direct means, but it can also, by methods of dietetic diplomacy, convert a virulent enemy into a good neighbour.

ENDOCRINOLOGY AND BIOCHEMISTRY.

The note of confident defiance thus conspicuous in bacteriology is predominant also in endocrinology. With a proper hormonic balance we are masters in any field. Our resources against enemy poisons, whether microbic or otherwise, are quickly mobilized and effectively employed. In the field of biochemistry it is the same. To look back upon the pre-vitamin days, and to contemplate the clumsy flounderings in anti-microbic dietetics, which prescribed everything boiled, and banned everything raw, is to marvel that there were not more C3 candidates for military commissions than there actually were.

Mistaken Ideas of Health

It is unfortunately the case that, so far as the general public is concerned, most of this recent knowledge in matters medical is still a sealed book. The knowledge is spreading, but it has not yet reached the stratum in society most in need of this kind of enlightenment. This stratum is typically represented by the fat, bald, prosperous man of fifty, who enjoys life, and demands of medical science only that it shall afford him the means of sinning against the laws of health without suffering. He knows nothing about those laws, and is very impatient if they are pointed out to him. He wants to do as he pleases, and to be protected from unpleasant consequences by his doctor. Having smoked tobacco to dirty pyorrhoeic excess, he soothes the resulting cough by lozenges, gargles, and sprays; remedies against which the only thing to be urged is that they are far too efficacious. His insomnia he cures with aspirin, his lethargic obesity with thyroid tablets, and his acidity by an extra glass of milk at bedtime. His psychology is obstinately and even aggressively obscurantist. Everything in the direction of moderation and restraint is a stupid fad. He eats generously and drinks freely, and is unable to believe that the things which he enjoys can do him any harm.

THE LACK OF SIMPLICITY.

Another thread which runs conspicuously through all the recent discoveries in medicine, which the general public find it hard to appreciate, is simplicity. Man's astounding success in so many fields of endeavour has begotten in him a false sense of proportion. When he contemplates a battleship or an aeroplane, or listens to a gramophone or a wireless, he is filled with a legitimate pride in his power and ingenuity, and not unnaturally persuades himself that he is, or ought to be, as transcendent in the physiological world as he is in the physical. He finds it difficult to recognize any solidarity between himself and the brute beasts which have no understanding. He feels that he ought to be able to manipulate and harness the vital forces even as he has harnessed the physical, and it will take him a long time and much suffering before he realizes that he cannot. In his endeavour to improve upon Nature he has swept simplicity on one side and substituted elaboration. This is well seen in the important matter of food. He has brought the artificial elaboration of his diet by means of cooking and otherwise to such a point that it is now hard for him to believe that simple uncooked foods are not only permissible, but are in some degree essential. The clothing which he has elaborated from very simple beginnings is now used less for protection against cold than for embellishment and class distinction. Freedom of movement is impaired by tight collars, tight

waists, and other contractions which interfere with the circulation of the blood. But man's clothing still errs grossly on the side of excess. He seeks to protect himself, not against undue cold, but against all degrees of cold. He thinks he knows better than Nature, who has given him a skin with astonishing powers of adaptability and adjustment, so he multiplies wraps where he ought to diminish them. He has not yet learnt that the more he wears the more he seems to require, because by increasing his clothing he lessens his adaptability. To-day woman is wiser, and she is teaching him.

Primitive man found it necessary to protect himself against inclement weather and the attacks of enemy beasts by building for himself huts and shanties. These were rude structures which admitted plenty of air and light. Man's ingenuity has evolved from them the modern house, centrally heated and capable of excluding every breath of air and every gleam of sunlight. The beneficent campaigns in favour of the open window and the ultra-violet rays have done much to remedy the harm which hermetically sealed and darkened rooms wrought in breeding and promoting diseases of the lungs and in stunting children's growth; but much remains to be done.

THE 'CHILL.'

The persistent false emphasis laid on the importance of the microbic seed, to the detriment of the cultivation of the resistant soil, together with the curious glamour of mystery with which all disease seems to surround itself, have combined to perpetuate the assumption that all maladies which cannot be attributed to a microbe, and many which can, are due to a 'chill.' What exactly is meant by the word 'chill,' no one seems to know. The theory probably originated in the days when vague fevers of an undifferentiated type, now, happily, abolished by sound sanitation, were exceedingly common. These fevers, being of a malarial type, were ushered in by feelings of chilliness, as many slight rises of temperature still are, and people, mistaking these chilly feelings for the cause of the disease, invested 'chills' with a degree of power and importance to which they have never been justly entitled. Had the story stopped there, no harm would have been done; but the chill theory has been, and still is, responsible for many obstinately shut windows, and for a degree of overclothing, especially of children, which does incalculable harm.

FOOD AND EXERCISE.

It is probably in the matter of due balance between intake of food and output of muscular exercise that man is most apt to claim a difference from the rest of the animal kingdom. He will not understand that, physiologically speaking, food is merely a means to an end, and

that, logically, no more of it should be taken than suffices to achieve that end, which is the maintenance of life on its highest level. Food is to man what coal is to a fire in an open grate; for food is actually burned in the body, mainly by muscular contractions, and, unless the amount of muscular work suffices to burn up the food, the wheels of our being become clogged, just as, when full of cinders, the coal fire smokes. Primeval man was obliged to exercise his muscles in order to obtain food. If he did not hunt his game or till the earth, he starved. Civilized man neither hunts his game nor tills the earth, but he does not starve. He eats plentifully, but he does not, unfortunately, see the necessity for taking exercise in the same proportion. Some there are, especially in this country, who seem when young instinctively to recognize the necessity for muscular exertion. The majority even of these gradually give it up as they approach middle-age; but instead of lessening their food intake, they increase it—some, because they frankly enjoy it; others because they believe it necessary to health.

It is very difficult to induce even highly educated and intelligent people to seize the idea that man lives by what he digests and not by what he eats. If, being in good health, he eats in excess of his immediate requirements, the overplus is stored away in the form of fat, against a lean period. If he is not in good health when he takes in the overplus he is unable to digest it and stow it away, so that it remains in his stomach and acts as an irritant. So far, then, from giving strength, an excess of food exhausts the digestive organs in a fruitless attempt to assimilate it, and gives rise to indigestion. This is what is likely to happen when a large eater gives up exercise entirely, or reduces it to the unscientific level of two rounds of golf on Saturday and Sunday—unscientific, because a week's muscular exercise crowded into a week-end is apt to lead to fatigue and attendant alcohol. The proper adjustment would be to redress the balance of diminished exercise by diminished food. Englishmen have made a fetish of violent exercise. This is a mistake, partly because such artificial outbursts are time-consuming, and partly because the body thereby becomes accustomed to a rapid and complete combustion of food-stuffs, setting a standard which cannot be maintained as the years advance, so that later the proper balance between intake and output is disturbed. Prolonged strenuous exercise of a spasmodic kind should be replaced by regular exercise on an increasingly moderate level, as soon as the days of pupillage give place to the serious business of life.

INSOMNIA.

The rapid pace at which life is now lived is alleged to have increased the tendency to sleeplessness which besets many nervous people. There is probably some truth in this; for mechanical advances are often

accompanied by an increase in noise—though as they are perfected this again decreases—and relative quiet is essential to sound sleep. There is certainly a subconscious awareness of noise, even though one sleeps. It is, on the other hand, also true that many people invite their own insomnia by demanding sleep, as it were, with clenched fists. This attitude defeats its purpose. Sleep is a coy maiden who refuses to be taken *vi et armis*. If she is treated as a matter of course, even with a certain amount of contempt, she will usually do what is expected of her. But sleeplessness is often far from being an affliction of the nervous system, caused by anxiety and emotional worries. It is much more often due to digestive troubles. A very slight degree of flatulent dyspepsia will cause a troublesome degree of insomnia, and if this is repeated for several nights in succession the situation gets on the patient's nerves, and he is liable to take to drugs and such-like folly. A simple antacid tablet of soda mint, or something of that kind, generally suffices to settle the dyspepsia and the despair at the same time.

A frequent and usually unsuspected cause of sleeplessness is the last pipe before going to bed. Some people, without knowing it, have an idiosyncrasy to tobacco. Contrary to the general supposition, in such people smoking irritates the nervous system, especially the nerves of the digestive system, and they ought never to smoke. A routine measure against insomnia which has much to recommend it is a hot bath at night. Sleep is induced by absence of blood from the brain area, and by withdrawing the blood from the head to the rest of the body, a warm bath produces the physical state most conducive to sleep. Some people take a glass of milk and a biscuit at bedtime in order to prevent insomnia; and inasmuch as anything put into the stomach withdraws blood from the brain, the glass of milk may well have the effect claimed for it. Unfortunately, however, such a step produces other effects more remote in their manifestation, which are altogether undesirable. An alcoholic so-called 'night-cap' is, in many ways, preferable to milk; but that, too, has disadvantages which counterbalance its merits.

IV—FOOD AND DIGESTION

The Refining of Food

For ordinary purposes anything may be considered as food which, when taken into the body, is capable of supplying material for growth and the repair of waste, or for furnishing energy for bodily heat and work. Man being the only animal who does not know instinctively how to select his food, the science of dietetics has arisen; and man being the only animal who cooks his food, this science of dietetics has become increasingly complicated as man's food has come to be further and further removed from the simplicities of his primeval state. It is important for us to remember that all our knowledge of food values has been derived from the study of simple natural uncooked food-stuffs, and that the ordinary meals of civilized man to-day are for the most part composed of materials which, by cookery and chemical refinement, have been rendered less suited to the digestive organs of ordinary healthy people. The changes wrought by cookery and refinement may be agreeable to the cultivated and artistic taste of the consumers, but it is certain that many of such changes render the foods much less easy of digestion than they are in their raw natural state. And it is equally certain that cookery, especially when prolonged and elaborate, is apt to deprive food of highly important, though imponderable, ingredients. It is a grave mistake to suppose, as is so often done, that natural uncooked foods are indigestible. A glass of raw milk is far more easily digested than a piece of boiled meat with greens and potatoes, followed by a rice pudding, but, to most of us, it is less interesting. It is possibly true that people who have been brought up on artificial foods are at first unable to digest natural foods, but a very short apprenticeship will restore the normal capacity. It must of course be conceded that cooking renders some foods more easily disintegrated in the digestive organs, and that organs thus pampered may at first rebel at crudities.

ROUGHAGE.

A serious objection to concentrated and refined foods is that they contain no 'roughage,' as it is called. By roughage is meant material in the food which is, by its nature, incapable of absorption. The part which such material plays is a very important one. It is present

typically in green vegetables and wholemeal bread. It supplies bulk to the food, and gives the digestive passages something to catch hold of. In the absence of such bulky residue these passages are deprived of a necessary mechanical stimulus, and fail in the performance of their function, with constipation as a common outstanding result. Nor must it be supposed that the absence of roughage is a merely mechanical matter; for the material which is cast aside in a so-called 'refining' process may have very considerable value in aiding digestion and nutrition.

CATALYSTS.

There are in Nature certain substances called catalysts about which not very much is known, but it is established that by their presence alone they can set in action chemical processes, which would otherwise remain inert, without themselves undergoing any change whatever —as, for instance, peroxide of hydrogen may be decomposed by the presence of metallic silver, whilst the silver itself undergoes no chemical change. Recent researches render it more than probable that in the material provided by Nature for man's consumption there are a certain number of catalysts; substances, that is, the presence of which enables the digestive organs to deal with the foods with which they are associated in Nature; whereas their abolition, by refinement or concentration, renders such foods relatively indigestible.

It must not be supposed that relative indigestibility shows itself by any outstanding symptoms. Between altogether indigestible things, such as woody fibre and a horse's hoof, to a food such as fresh human milk, which is rapidly, completely, and easily absorbed, there are many stages. Those nearest to the woody fibre end of the scale contain substances which, though the digestive organs eventually succeed in converting and utilizing them, demand the expenditure of such an amount of energy that a person who may be quite unconscious of any digestive difficulties may yet be rendered lethargic and irritable by the diversion of energy from its proper channels into the digestive tract. This kind of unobtrusive indigestion is responsible for a great many symptoms which are seldom attributed to their true cause.

Variety of Food

These considerations have a bearing upon another factor which demands a place in every successful scheme of dietetics, namely, variety. There are many people who allow their digestive organs to become 'bored' or 'stale,' so to speak, because they have become slaves to regularity, and to what they regard as suitability. The regular weekly round of the same foods at the same hours on the same days becomes a

sort of treadmill to the satiated senses. However correct the meals may be from the chemical point of view, their sameness means that the digestive organs are deprived of the normal stimulus of appetite. The victim eats the food because it has been provided for him, but he eats it without relish, and digests it with difficulty. That variety is desirable is shown by the diversity of foods which Nature furnishes for our use at the different seasons. The weariness of *toujours perdrix* does not apply only to delicacies.

Into any discussion of this kind there must always enter the disturbing element presented by differing capacities of different individuals for dealing adequately with certain kinds of food. It is undoubtedly correct to say that in their physiological make-up some people tend to revert to their carnivorous ancestors, and are happy only when deriving the major portion of their sustenance from the animal kingdom; while there are others who display their herbivorous heredity by their inability to deal adequately with meat foods without invoking disagreeable symptoms. Both of these types are quite sound and normal, but they are physiologically happy and comfortable only when they are able to select their food with due regard to their physiological peculiarities. A perfectly healthy inhabitant of the temperate zone should, in theory, be able to digest and utilize any of the ordinary foods in common use, but in practice it is found that the artificial life which is forced upon most town-dwellers has its repercussion upon their digestive capacities. The citizen's power of dealing with meat foods shows a definite decline as soon as his athletic period is over, and such foods become more and more harmful to him as the years advance. His increasingly inactive muscles fail to burn up the fleshy toxins, which accordingly deposit themselves in his joints and elsewhere. Foods derived from the vegetable kingdom are not so deadly in their potentialities as are the flesh foods. The man who hunts his game with arm and sinew is physiologically entitled to eat it; but the man who watches the operation in pictures from a cinema *fauteuil* is not. Such a one as the latter should eat little flesh, and plenty of eggs, fruit, and dairy produce.

The differences between the types of food derived from the animal and vegetable kingdoms respectively are, in reality, much more fundamental than would appear at first sight. All our foods are derived from plants, or from animals which have lived on plants. In fresh food there are certain highly important substances called vitamins, to which detailed reference will be made later; but it is relevant here to point out that the vegetable kingdom is the source of all of these; and that, roughly speaking, it may be said that cookery, especially prolonged cookery, effectually destroys the principal vitamins. Setting these facts side by side, we see that flesh foods must, so to speak, borrow their vitamins from a vegetable source; and, inasmuch as all flesh is cooked

before it is eaten, such vitamins as it contains are in serious danger of being by that process diminished below the standard of safety, if not entirely abolished. Fortunately most people now live on a mixed dietary, in which vitamins are well represented by raw fruits, salads, and so on.

Quantity of Food

The quantity of food required by any individual depends upon many considerations, some of which are obvious, while others are not so immediately clear. It is, for example, obvious that a labourer who works his muscles hard for eight hours daily will require more food than the clerk who sits on a stool adding columns of figures for the same period; that days of external cold demand that more fuel shall be burned in the body than on days of tropical heat, for which reason the denizens of the temperate regions take and require more muscular exercise than do those of the tropical. But it is by no means easy to explain 'the appetite which comes with eating,' or to find a sufficient reason for the fact that brain work in the study often creates a desire for food even more insistent than does an equivalent amount of exercise in the open air. That the nervous system plays a large part in wasting or in using up food is well seen in the emaciation brought about by continued loss of sleep. It is indeed true that many people habitually demand more food in periods of severe mental stress than they do in ordinary circumstances.

It is, however, in general, correct to say that the subconscious or physiological demand for food, after the growing period, is determined by the expenditure of material in work and energy. Most people learn naturally to preserve a physiological balance between intake and output, the kind of balance which experience teaches them is best suited to their needs. There are 'fat kine' and 'lean kine,' and both are individually normal so far as maintenance of efficiency is concerned—but that does not alter the fact that the lean kine last longer.

The food requirements of the individual vary with age and sex. In young people, during the growing period, the need for food is necessarily larger than it is later on, when material is wanted for maintenance only, and not for the formation of new tissue. The period round about the age of puberty, and that of the passage from adolescence into complete adult life, demand nutritive material for all the systems, more especially the nervous system, far in excess of demands in less critical periods. As the years advance, the physiological necessity for food gradually declines, while the appetite unfortunately does not; and as the monetary power of satisfying the appetite often increases, the period about middle age is apt to be punctuated by symptoms pointing to a surfeit of mild degree. It is a fortunate thing when the surfeit declares itself in unmistakable obesity, for then the victim's own vanity or the criticisms

of his friends may lead to improvement. If, however, the surfeit is shy of showing itself outwardly, it may work inwardly upon heart and arteries, and other vital organs, whose implication may not be discovered until irreparable damage has been done. The advent of middle age should carry with it a serious warning to men and women that they should suit the amount of their food rather to their real physiological requirements than to their capacity for enjoying the pleasures of the table. It is sad that when we can at last afford to pay for longed-for luxuries, Nature will have none of them.

If reduction in quantity and a return to simplicity in quality are the dietetic reforms demanded by middle age, the need for them in old age is even more imperative. The person who attains to real longevity does so usually on a diet which to the ordinary person will seem fantastically inadequate; yet people are for ever urging old folk to take more and more food in order to 'keep up their strength.' Woman, even during her reproductive period, requires less food than the ordinary man, owing, no doubt, to her smaller output of muscular energy.

Quality and Composition of Food

It needs very little imagination to realize that, the life of the individual being a continuous process of waste and repair, the exact nature of the material used for such repair is a matter of paramount importance. What we eat will, in the long run, determine what we physiologically are. If, from childhood onwards, we eat the right things, by middle age we shall have built up for ourselves a 'strong constitution,' as it is called. This means that we shall have developed a natural resistance to microbic and other attacks from outside, and learnt how to deal with minor derangements from within. The man who has been well brought up physically, who at the age of thirty is vigorous and wholesome, has been given a real opportunity of 'expressing himself,' as the saying is. He is not at every turn obliged to consider his physical needs; he takes his muscular strength and freedom from pain for granted, and is consequently able to throw his whole energy into the development of his character and the prosecution of his work in the world. The other side of the picture is presented by the weakling of the same age who, owing to faulty feeding on over-cooked and over-refined foods, has had adenoids at five and appendicitis at ten; and has now rickety bones and under-developed muscles. He is seldom really ill, but often has catarrhs, sore throats, and irregular temperatures. He cares nothing for outdoor pursuits, and work in the study gives him headaches. He may live to a good age, but his passage through life, instead of a triumphant march, will be a series of petty and querulous rear-guard actions. If he had been properly fed during infancy, childhood,

and youth, he would, in spite of possible hereditary taints and drawbacks, have reached maturity as a worthy specimen of his race.

It is interesting to speculate on the extent to which what we eat determines what we become. Some people, thinking to build up strong children, and deeply imbued with the conviction that the only foods containing any real nutriment are the meat foods, especially 'the roast beef of old England,' begin, as soon as the child is weaned, the process of stuffing him with flesh foods (which he is encouraged to eat nearly raw); a course which continues usually up to middle age. Apart from the strain upon the excretory organs which such a regime entails, the wholesale ingestion of flesh seems in many cases to have a harmful repercussion upon the character of the ingester. He may be quite a good—too good—physical specimen, but he grows to resemble a carnivorous animal in his nature. He is often assertive, dictatorial, combative, and irritable. Those who are responsible for his upbringing may deplore his faults and his consequent unpopularity, but they are very reluctant to admit that 'good sound food' can have had an unfavourable influence on his character.

The material of which food is composed may be allocated to one or more of certain comprehensive chemical categories or groups, called the proximate principles. The chief of these are the proteins, the carbohydrates, the fats, and the mineral salts, together with substances known as vitamins, and others known as catalysts, which have already been mentioned. It is unfortunate that our knowledge of these matters is still so incomplete as to necessitate rather complicated conceptions. Simplicity will doubtless come later. In the meantime it is desirable here to define certain technical terms which are likely to insinuate themselves in spite of the most determined attempts to exclude them.

CALORIES.

'The standard of heat-production is called the Calorie, which is the amount of heat required to raise one litre of water 1° C. or, what comes to the same thing, to raise one pound of water 4° F. . . . The question naturally arises: "Is such a combustion true for the body? does the body oxidize foods as they are oxidized in the bomb-calorimeter?" The answer is that "it does not."' The foregoing, which is a quotation from a recent authoritative textbook on Dietetics, shows that the calorie is really a very unsatisfactory standard. It will be employed here as little as possible, but a definition of it has been deemed advisable in view of the fact that it is very commonly used in modern discussions on food.

METABOLISM.

Metabolism, or tissue change, is defined as the chemical changes which occur in the tissues of a living organism. It is a concomitant

of all life and growth, and is the source of the energy liberated in the body for the purposes of movement and the production of heat. It is convenient to regard these changes as of two types: (*a*) in which simple chemical substances are built up or synthetized into more complex forms; and (*b*) in which complex chemical substances are broken down into simpler ones. To the former (*a*) the term 'anabolism' is applied; the latter (*b*) is called 'katabolism.'

PROTEINS.

Proteins are complicated substances, composed largely of nitrogen, upon which the body relies for its maintenance of metabolism. They are therefore essential constituents of all dietaries. Proteins are found largely in flesh foods, butcher's meat, fish, poultry, game, eggs, and cheese; they are also present in considerable quantity in certain vegetables, notably peas, beans, and lentils. The ordinary diet of civilized man, certainly of the well-to-do, in the temperate zone tends to contain too much rather than too little protein.

CARBOHYDRATES.

The carbohydrates consist mainly of starches and sugars. Starches are present in considerable quantities in rice and potatoes; bread contains starch, so do green vegetables, fruits, and nuts. Before starch can be digested it must be converted into sugar, a process which demands a good deal of energy. When the digestive organs are fatigued by an excessive amount of this conversion, the result is a form of indigestion which, unless its real meaning be recognized, is apt to give rise to considerable trouble. Not all sugars are easily absorbed; only those which are found in Nature, such as those present in fruits and vegetables and in honey, are readily digestible, and it is into this kind of sugar that starches are converted in the body so as to render them easy of digestion. Several kinds of sugar exist in food-stuffs, and they must all be converted into the easily digestible form before they can be utilized by the body. Certain forms of sugar, therefore, in addition to the starches, if taken in excess, are liable to fatigue the conversion apparatus and cause indigestion. White commercial sugar, as we know it, is a highly refined artificial product, which is more difficult of conversion than starch, starch being a natural substance for the conversion of which due provision is made in our digestive apparatus. Refined sugars are foreigners and intruders, for which no provision has been made; they, in consequence, tire the converting mechanism and irritate the mucous membranes. People speak about 'sugar' as though it were a distinct chemical entity with no varieties. It would be just as reasonable to speak of 'oil' without differentiating between paraffin and salad oil.

The importance of sugar as a food is so great that we should endeavour

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SETTING BONES IN SPLINTS

Reducing fractures and dislocations

From a treatise translated into thirteenth-century French from MS. of 1180

to obtain a working knowledge of the position occupied by the several varieties of the substance in ordinary dietetics. This is not meant to encourage undue concentration on dietetics in general, or on any branch of it, but merely to set out a few facts which have an important bearing upon the maintenance of health. It is convenient to divide sugars into two categories, which may be called: (1) the single, or simple, sugars, such as grape sugar, fruit sugar, and honey sugar; and (2) the double, or complex, sugars, such as cane sugar and beet sugar. Grape sugar can be made artificially by boiling starch with acids. When heated it turns brown, and is used in cookery as 'sugar colouring.' Mixed with white of egg, it is employed in the preparation of icing, and in the manufacture of bon-bons. It is relatively easy of digestion.

Fruit sugar is very easy of digestion. This is no doubt partly due to the fact that it cannot be extracted from any fruits because it is uncrystallizable, which means that it is necessarily eaten in conjunction with other substances with which it is found associated and, so to speak, diluted, in Nature. It cannot be divorced from the substances whose presence with it renders it easy of digestion. Honey also belongs to the class of single simple natural sugars which are easy of digestion. The honeycomb wax is not digested. It acts as roughage.

The double or complex sugars are represented chiefly by cane sugar and beet sugar, both of which, as we know them, are highly refined and concentrated articles which have been completely divorced from the substances with which they are associated in Nature. Their degree of concentration may be gauged from the surprising fact that it requires about fifty sticks of ordinary sugar-cane to make one pound of loaf sugar. Every ordinary lump of sugar is equal to about two feet of cane. Children, therefore, frequently eat the equivalent of twelve feet of sugar-cane in a few minutes, while many adults consume the equivalent of two to six feet of sugar-cane in a cup of tea. These facts are all the more perturbing when one realizes that cane sugar in solution is an irritant to the tissues. In contact with the unbroken skin it is liable to set up violent inflammation; and rashes produced in this way may often be seen on the arms of grocers and other persons who handle sugar. Injected under the skin it causes a very painful condition. It seems likely that it can have an irritating effect upon the delicate lining of children's stomachs, and may even produce in adults a chronic irritation which may have serious consequences.

In the preparation from the crude cane of the refined white loaf or lump sugar as seen on the English tea-table, there are several stages, and some by-products result. Among such are treacle, molasses, and golden syrup, all of which, from the fact that they still retain many of the substances found in the sugar-cane (called impurities) which render the sugar more digestible, are from the dietetic point of view much to

be preferred to the concentrated loaf sugar. Unfortunately, on account of their syrupy consistence and absence of 'refinement,' these desirable substances are not popular. An effort should be made to reinstate them in general favour. There are sugars which, though still containing the despised 'impurities' in appreciable degrees, are no longer syrupy like treacle, but have attained to a state of crystallization enabling them to be handled easily. One of these is known as Barbadoes sugar, a very dark sugar. The dark colour, as in the case of treacle, indicates that the 'impurities' are well represented, and that the sugar is very digestible. The same is true to a less extent of Demerara sugar, which, being lighter in colour than Barbados, is to that extent less good. It is, however, very much to be preferred to white loaf sugar.

The only other form of double or complex sugar with which we need be concerned here is beet sugar. The discovery that beetroot and other tubers contain sugar identical with that obtained from the sugar-cane was made in Germany in 1747. It was at first regarded as a matter of purely academic interest, but by degrees its commercial possibilities became apparent, until now beetroot supplies the world with fully two-thirds of the sugar commonly used. Unfortunately, there are no crudities or impurities in beet sugar, and no by-products result from its manufacture from the beet, so that there are no intermediate stages, such as those of treacle and Barbadoes sugar, to record.

When strongly heated, sugar melts into a yellowish liquid, and undergoes certain physical alterations, so that on cooling it does not crystallize, but forms a transparent brittle mass familiar to every one by the name of barley sugar. This is very concentrated. If heated to a still higher temperature its colour darkens, and it acquires a bitter taste; the product being caramel, which is largely used in cooking operations. Sugar candy is merely cane sugar, highly refined, which has been allowed to crystallize round cotton threads. Toffee consists of melted sugar and butter in about equal proportions. When properly made it is a very nutritious substance, containing a fair proportion of the right kind of sugar. Chocolate consists of ground cocoa, from which the fat has not been removed, mixed with highly refined white sugar. The co-called 'cream' found in association with chocolates consists of a combination of two forms of white refined sugar. Jam is made, as a rule, from fruit and refined white cane sugar. The process of manufacture—boiling for a considerable time—has the effect of converting the undesirable white sugar into the more acceptable fruit sugar like that contained in the fruit itself. It is a genuine conversion from a state of sin to a state of grace, and renders jam a highly nutritious and desirable form of food. Home-made jam is usually boiled for a longer period than commercial jam, so that the conversion in the case of the former is more complete. As will be seen later,

however, prolonged boiling certainly destroys some of the vitamins. Inasmuch as these can be obtained from other foods, this drawback is easily countered.

Commercial glucose, made by treating starch with an acid, does not crystallize. It is used by manufacturers to make jam from inferior fruit, or from the residue of fruit from which the juice has been expressed for making syrups and jellies. The product usually has a good appearance, but it is very deficient in flavour and nutritive power.

FATS.

Fats include all the animal fats, such as suet, dripping, lard, bacon-fat, butter, cream, and the fat of egg yolk; together with the vegetable fats, olive oil, cotton-seed oil, nut butters, and margarine; and fish fats, such as cod-liver oil and halibut oil. Suet, which is an animal fat obtained from sheep and oxen, is a common food in cold countries. Lard is melted pig's fat. From the point of view of their content of Vitamin A, which in some circumstances is a very important matter, it is well to recognize that the fats of animal origin, such as cream and butter, egg fat, suet, and cod-liver oil, are superior to the fats of vegetable origin, such as almond oil, olive oil, and cotton-seed oil. Pork fat, however, contains but little of Vitamin A. Fats are necessary in all diets, but the needful amount varies with climatic and other conditions.

MINERAL SALTS.

The importance of the mineral constituents of food may be gauged from the fact that if the supply of these constituents is completely cut off, death ensues within about a month, even though all the other constituents of a normal diet are supplied as before. The above statement, however, comprises most of what is at present known on the subject of our mineral requirements. It has, of course, been established for a long time that calcium, phosphorus, iron, magnesium, sodium, iodine, and other elements are necessary to health, but we have as yet nothing to guide us as to the daily amount of mineral matter which the body demands for the maintenance of its equilibrium. Meat, fish, cereals, vegetables, and fruits are all sources of mineral dietary elements. The mineral salts dissolve in the fluids of our body, and play a vital part in regulating the work of different organs; if certain of these salts are absent from the food, the heart will cease to beat. The red colour of the blood corpuscles is due to iron. Lime salts and phosphorus are essential to the development of bones and teeth in the growing period. Common salt is necessary for the gastric juice. But all these chemicals, and others, some of which are required in very small quantities, are present in any diet which includes a fair variety of natural food-stuffs; so that there is no danger, in well-to-do

civilized life, of any shortage of mineral matter, except in the case of those who foolishly depend to too great an extent upon such articles as white flour and refined sugar.

WATER.

The majority of our food-stuffs contain fluid; some of those from the vegetable kingdom to a degree which is very surprising. Man was at one period of his evolution an amphibious animal, and he still depends in large measure upon water, internally and externally, for the due performance of his physiological functions. Fluid as it presents itself in food is always combined with other material; it already carries all kinds of things in solution and in suspension, so that although it is useful for flushing purposes, it has no value as a solvent. For example, milk is a fluid; but it is so charged with food-stuffs that it is unable to dissolve, say, sugar or common salt. It can suspend these substances, but it cannot dissolve and incorporate them as, say, distilled water is capable of doing. For this reason, though raw fruits and vegetables, by supplying fluid to the tissues, will slake a conscious thirst, they will do nothing to supply the solvent which is necessary for the removal of waste matters from the system. Every one should make a point of drinking from four to six pints of a pure soft water in the twenty-four hours. Tea and coffee are both solvent fluids. Milk-made cocoa is not. It is probable that the cures effected at spas and health resorts are due in an appreciable measure to the large amount of fluid which the patients are made to drink. The exercises and other physical treatment force the waste matters into the circulation, and the fluids dissolve them and flush them out.

So much, then, for what may be called the ponderables in our foods. Before proceeding to consider the vitamins, which are almost imponderable, it is well briefly to recapitulate what has gone before, by reminding ourselves that proteins are represented by lean meat, fish, poultry, cheese, and eggs; that carbohydrates are represented by bread, rice, potatoes, the other cereals, and sugar; that fats and oils are typified by butter and olive oil and nuts; and that mineral salts are found abundantly represented in fresh fruits, salads and vegetables.

VITAMINS.

The conception of disease as caused by the absence of a something in the food instead of by the presence of a microbic or morbific agent—by a minus instead of a plus—seemed very revolutionary to a generation brought up in the belief that Lister and Pasteur, by initiating the science of bacteriology, had solved the riddle of all maladies. And yet the facts had been available for him who runs to read, from the moment at which it was discovered, as far back as the eighteenth century, that

the horrible disease scurvy was due to an absence of fresh fruits and vegetables from the diet. All kinds of theories were advanced to explain the cause, which we now see to be dietetic, of rickets in European children, and of diseases in the East known as beri-beri and pellagra—to say nothing of many vague but disquieting departures from health which seemed beyond the reach of drug therapy. Into this chaotic darkness, Sir Gowland Hopkins shed a most welcome and helpful ray of light by publishing, in 1912, some experiments which he had made, showing that in addition to proteins, carbohydrates, fats, and minerals, there were in food-stuffs some elusive substances, called by him 'accessory food factors,' which were essential to the life and growth of all animals. These substances are now known as the vitamins. Since that time at least six vitamins have been clearly differentiated. No doubt others exist which, when discovered, may be found to be of scientific rather than practical importance. For the sake of simplicity the best-known vitamins are called A, B, C, and D, each one of which is indispensable in its own department. One vitamin cannot deputize for another, as in the case of the food-stuffs proper, where meat can be effectively replaced by cheese, or rice by oatmeal, or olive oil by lard. Vitamin A, for example, cannot replace Vitamin B, and if for a period of three or four months any of these vitamins be not supplied in the food, very serious consequences, and even death, may be the result. It is important to remember that vitamins are present only in very small quantities in any of the food-stuffs, though more in some than in others; that they are very easily removed from foods by the milling of grain, by steeping in water, by cooking—especially for long periods at a moderate temperature—and are completely destroyed by certain chemicals. It has already been said, but it will bear emphasizing, that all vitamins are formed primarily in plants, and that such vitamins as are present in animal tissues are derived from the plants on which these animals have fed. Clearly, therefore, from the vitamin point of view, vegetable foods have a decided advantage over animal foods.

Not many of the individual foods in common use contain all the vitamins. Vitamin A, for example, is found in green vegetables and in all the animal fats except lard. Vitamin B is found principally in the seeds of plants, and in the eggs and internal organs of animals. Vitamin C is present in all fresh fruits and vegetables. Vitamin D is nearly always associated with Vitamin A in animal fats. Cod-liver oil and halibut-liver oil are especially rich in both Vitamin A and Vitamin D.

The best fruits for the easy supply of Vitamin C are oranges, lemons, tomatoes, pineapples, strawberries, apples, and bananas—in that order. Curiously enough, grapes are almost useless from this particular point of view. The vegetables which hold this vitamin in greatest abundance are watercress, spinach, cabbage, green peas, cucumber, and carrot.

All these may be eaten raw as well as cooked. Cooking, though it does not in every case destroy vitamins, is very liable to interfere with them.

Milk and its Derivatives

Most of the ordinary foods contain the foregoing proximate principles, proteins, carbohydrates, fats, salts, and vitamins, in various proportions. In some foods there is a very large preponderance of one element over the others; meats, for example, consist so largely of protein that there is a consequent shortage of the other elements so serious as to render an exclusive meat diet quite unsuitable for prolonged use. It is the same with the other foods; potatoes, for example, contain little else than starch. The only form of ordinary food which is scientifically complete is milk. There are of course several kinds of milk—cow's milk, human milk, goat's milk, etc., and several categories of cow's milk—but in all of them the proximate principles are represented sufficiently to maintain life and promote growth over long periods of time. When it is realized that for the first year or so of life milk is practically the only food of a human infant, the importance and sufficiency of this form of nourishment is obvious.

COMPOSITION OF MILK.

The *Protein* in milk, which constitutes about 3% of its total weight, is present in the form of what is usually known as casein. Roughly speaking, it is that part of the milk which supplies the curd and the solids which go to the formation of cheese. Casein has some very special advantages over every other form of animal protein. Important is its power of neutralizing acid in the stomach; whilst another advantage lies in the fact that it contains the all-essential element phosphorus in a particularly digestible form. Casein is exceptionally easy of digestion and absorption.

The *Carbohydrate* constituent of milk is milk sugar, or lactose, which is present to the extent of about 5%. Lactose differs in many ways from every other form of sugar, but in nothing more than in its almost complete freedom from sweetness of taste. This is a valuable quality, because sweetness so easily palls. Milk sugar is not capable of being fermented by yeast. This substance, though chemically a sugar, is thus lacking in the two most conspicuous characters of the substances usually known by this name: it is nevertheless a full member of the great carbohydrate family, and, as taken in milk, it affords an excellent example of the dietetic efficacy of a sugar which is neither concentrated nor refined.

The *Fat* of milk contributes about 4% to the total weight. It is

important to remember that the amount of fat in the different kinds of milk varies with the type of animal which secretes it; when the climatic conditions demand much fat, the animal's milk supplies it. The milk of the whale, for example, contains no less than 43%, as against a maximum of 5% in the milk of cows living in the temperate zone. Fat, is present itself in milk in the form of an emulsion or mixture of quite wonderful fineness. It is calculated that in one drop of milk no larger than a pin's head, there are no less than a million and a half of separate fat globules. Oil which is so finely subdivided is necessarily very easy to digest. When milk is allowed to stand, these oil globules run together and float on the surface as a separate and distinct layer—the cream.

It is, however, a mistake, often made, to speak of cream as consisting of pure fat, for it contains a large proportion both of casein and milk sugar. Indeed it may be said that cream is merely milk which has lost a large proportion of its water. It should contain 40 to 50% of butter-fat, together with 2·5 % of casein, 4·5 % of milk sugar, and 0·5 % salts. Devonshire or Cornish, or clotted, cream is prepared by heating the milk in deep pans, which causes a rapid and very complete separation of the fat. The proportion of oil in such cream is nearly 60%. The cream thus prepared contains only about half the amount of sugar present in ordinary cream; a fact made use of in the dieting of diabetics.

One of the principal uses of cream is in the production of butter, which is effected by churning. The churning causes all the fat globules in the cream to run together into a solid yellow mass. The casein, milk sugar, and salts remain behind in the fluid, which is then known as buttermilk. This is very cheap and very nutritious, and although it has a peculiar sour flavour, children soon acquire a taste for it.

Water is the only remaining constituent of milk to claim attention. It is surprising to find that such a nutritious fluid contains no less than 87 to 88 % of water; yet such is the fact. And it is curious to note that for an ordinary healthy person milk is not a *fluid* food; it solidifies into clots or curds as soon as it enters the stomach.

COMPOSITION OF CHEESE.

A derivative of milk which plays an important part in human dietary in all countries is cheese. Cheese consists of the casein and the fat of milk, and the differences between the various kinds of cheeses are largely due to the relative quantities of these two main constituents. In the hard cheeses, such as Cheshire, Cheddar, Roquefort, and Caerphilly, most of the fluid is squeezed out of the mass, whereas in the soft cheeses, such as Camembert, Gorgonzola, Limburg, and Stilton, a fair amount of it is allowed to remain.

It is often said of cheese in general that it is difficult of digestion.

Such truth as there may be in this statement is due to the large amount of relatively insoluble fatty matters which all cheeses contain. The fat forms, so to speak, a waterproof coating which protects the mass from the action of the gastric juices. If, however, the cheese is thoroughly broken up by mastication, this objection does not hold; and, as a hard substance is more likely to be thoroughly chewed than a soft, the hard cheeses are less open to the charge of indigestibility. There is, however, no reason why cheese should not be grated (as in dishes *au gratin*) or otherwise subdivided before it is eaten or cooked. In the case of those who find a real difficulty in digesting cheese, a little ingenuity in breaking it up and combining it with other substances, either cooked or uncooked, should certainly be exercised, because, if it can be digested, cheese is by far the best available substitute for meat and flesh foods. The high nutritive value of cheese is generally appreciated; scientifically it may be expressed by saying that 'a pound of Cheddar cheese represents the casein and fat in a gallon of milk,' and that 'beef contains less than half as much nourishment as the same weight of cheese.'

CONTAMINATION OF MILK.

Before leaving the subject of milk and its derivatives, it is well to consider the one serious drawback to milk as a food, namely, its admitted liability to contamination. This is a very serious question, which has engaged, and is still engaging, the attention of those who are interested in the public health. There are two schools of thought in the matter. One of them seeks a method of so treating milk as to render it completely free from dirt and micro-organisms in general, and from the bacillus of tubercle in particular. The other holds the view that, while the general cleanliness of milk is essential, and while all reasonable care should be exercised in transporting it, the ideal of a bacillus-free milk is practically impossible of attainment; and, that even if such an ideal were realizable, it would not be advisable. The abolition of micro-organisms, they urge, would mean the disappearance not only of our bacterial enemies, which are after all not many, but also of our bacterial friends, which are numerous and important. It is certain that some of our digestive processes are aided by friendly bacteria, and it is probable that other physiological happenings gain from this kind of extraneous assistance. It has, moreover, been argued that an over-scrupulous regard for complete freedom from bacteria would deprive milk of its valuable immunizing power. By this is meant the power possessed by small and relatively harmless doses of a poison, continually administered, to mobilize the defensive resources of the individual, so that he gradually becomes impervious even to mass attacks. Modern knowledge of immunization would, indeed, suggest

that minute doses of tubercle in milk may have some effect in 'hardening' children against the evil influence of underfeeding and insanitary conditions. Every one must agree that it is highly desirable that the community should be supplied with clean, wholesome milk, in the same way as it ought to be—and for the most part is—supplied with uncontaminated water.

It is, of course, very easy for dishonest people to dilute milk, and if the water used for such dilution is polluted, the results are such as to defeat the most stringent measures for securing purity at the source. Milk is sometimes diluted with pure water, and its specific gravity thus reduced. But, for reasons into which it is unnecessary to enter here, the specific gravity test is recognized as unreliable. The whole quality of a specimen of milk may, however, be simply and summarily gauged by estimating the quantity of contained fat or cream. A milk which is rich in cream is also rich in protein, carbohydrates, and salts; a 'thin' milk, containing but little cream, is always poor in the other constituents. Commercially, too, there is sufficient reason for accepting the amount of fat as the standard of the money value of a milk, for the reason that the fat of milk (cream) is its most expensive constituent.

DIGESTION OF MILK.

Milk being thus a very complete and, in a sense, a very concentrated food, discretion should be exercised in adding it to other foods. It may be diluted with water or soda-water, or it may be so treated as to prevent its forming a solid clot in the stomach as, especially in acid stomachs, it has a tendency to do. Probably the best way to prevent this is to add a small quantity of citrate of soda (as much as will lie on a sixpence), previously dissolved in a teaspoonful of water, to each tumblerful of diluted milk.

EGGS

After milk the nearest approach in nature to a scientific ideal food in a small compass is the hen's egg. Inasmuch, however, as an egg is almost completely devoid of carbohydrate, it is far from being a complete food; and owing to the fact that eggs are nearly always eaten cooked, they must, to that extent, be regarded as deficient in vitamins. They furnish us, nevertheless, with a very remarkable food of fairly regular composition, and particularly rich in the mineral salts upon whose presence so much depends in our growing period. There appears to be no difference in composition between eggs with dark shells and those with white shells. The former are preferred by the British public, but merely on 'artistic' grounds. Americans, on the same grounds, prefer white eggs. The composition of an ordinary egg is approximately as

follows: shell, 11·2%; water, 65·5%; protein, 13·1%; fat, 9·3%. In the matter of digestibility it is to be noted as a matter of curiosity that a lightly boiled egg is more quickly disposed of by the stomach than a raw egg; but eggs, however taken, whether cooked or raw, are generally very well and quickly digested. Nevertheless, among the articles of food to which some unfortunate people display a violent physiological antipathy, eggs take a high place. Some people with this idiosyncrasy are unable to swallow even a small particle of egg without becoming violently and alarmingly ill. The symptoms in slighter cases, though not so alarming, are definite and very unpleasant. Among such are urticaria, vomiting, attacks of asthma, and other manifestations which are not usually associated by the lay public with dietetic peculiarities. The portion of the egg usually responsible for these troubles is found to be the white.

There is not much difference in composition between a hen's egg and a duck's egg. Duck's eggs are somewhat larger, but many cooks do not like them, saying that they cook badly, are difficult to omelet or scramble, and mix badly with hen's eggs. Many people, again, object to duck's eggs on the ground that they have an unpleasant taste and smell; though the eggs of the Indian runner and its relations are almost free from these. It is certainly true that in comparison with hens, ducks are dirty feeders, and this fact may partly explain the widespread prejudice against their eggs. Turkey's eggs and guinea-fowl's eggs are not open to these objections.

Other Animal Protein

MEAT, POULTRY, ETC.

Of the other foods derived from the animal kingdom, by far the most important is meat or flesh; that is, muscle. It is convenient to divide flesh foods into butcher's meat, poultry, and fish. Butcher's meat consists almost entirely of protein, together with some fat and much water. Mutton contains more fat than beef, pork more fat than mutton, and bacon no less than 60% of fat. None of the butcher's meat foods contains an appreciable amount of carbohydrate. As to the relative digestibility of the various kinds of meat, it is a general rule that the digestibility varies inversely as the fatty content. There is a popular belief, which seems to be very ill-founded, that mutton is particularly digestible. Inasmuch as mutton fat, especially when hot, often proves irritating to the stomach, action based on this fallacy may easily give rise to digestive difficulties. It is often said that cooking renders meat foods more digestible. There would seem to be some fallacy in this, for all physicians agree that raw or, at all events, very underdone meat is a form of food which

patients with weak stomachs can digest more easily than most other forms of nourishment. It takes us back to primitive man, who hunted his game and ate it raw. As bearing upon this point, it is interesting to find that the flesh of hunted animals is highly prized for its taste, on account of the acid fatigue-products which the muscles contain. It is to produce the same gustatory effect that some gourmets have their flesh foods soaked in vinegar before cooking.

Poultry contains much the same percentage of protein as lean beef (20%), but more fat; 8% in young chicken, rising to 20% in turkey, 26% in duck, and 31% in goose. The breast of chicken and game is probably the most digestible form of flesh food. The legs, on the other hand, are often very tough. Very fat duck and goose should be avoided by those with delicate digestions; the fat of such birds, in conformity with the general rule, renders the muscle difficult of access to the digestive juices.

Certain of the animal organs (known colloquially as 'offal') have definite qualities which justify their differentiation from the main carcass of the animal and from one another. The liver and kidneys resemble each other physically in being compact and homogeneous organs, consisting almost entirely of protein, with a small part of fat. Liver especially is a very good and relatively inexpensive form of protein food. 'Sweetbread' is a name given to both the thymus gland and the pancreas of the animal. In either case it is a very easily digested form of protein. Tripe is the name applied to the stomach and intestines of the ox after being cleaned and boiled. It contains fat, as well as protein, but is nevertheless very digestible. It is unfortunately rather insipid, which is presumably the reason why it is usually served with onions. Perhaps the most surprising thing about these flesh foods, which are usually regarded as solids, is the high proportion of water which they contain. Thus, lean beef contains 76·5% of water; lean mutton, 75%; hare, 74%; rabbit, 66%; fowl, 70%. When flesh foods are cooked, even when they are boiled, they lose an appreciable amount of their water, together with a certain amount of fat and some of the mineral salts.

GELATINE.

The substance known as gelatine has occupied a place of some importance in dietetics. Gelatine is a stiff elastic material obtained by boiling solid and semi-solid parts, such as bone and cartilage. Its distinguishing characteristic is that of dissolving in hot fluids and forming a jelly on cooling. When pure it is colourless, transparent, and almost tasteless. Its purest form is isinglass, made from the air-bladders of fishes. Glue and size are impure forms of it. It is used for making all kinds of jellies, and for the manufacture of photographic

plates, and explosives. The skeletal portions of young animals are particularly rich in gelatine; calves' feet, for example, have long been known as abundant yielders of jelly.

From the point of view of nutrition, gelatine is now regarded as a para-protein, which is defective in certain important constituents of real protein, and cannot therefore be regarded as a substitute for, say, meat or cheese. As an adjunct to other forms of protein, however, it is of considerable value. It has the great merit of fixing and neutralizing acids in the stomach, and may therefore usefully be added to ordinary foods in cases of acid dyspepsia.

FISH.

Fish is a form of protein food which is usually believed to be exceptionally digestible, and it is a matter of everyday experience that delicate stomachs are able to deal with the lighter and whiter fish more easily than with almost any other form of protein. Fish resembles meat in consisting almost entirely of protein and fat. The amount of fat varies very much. For purposes of classification fishes are divided into three groups: (*a*) Those with more than 5 % of fat, including eel with 18 %; salmon, 12 %; turbot, 12 %; herring, 8 %. (*b*) Those with 2 to 5 % of fat, such as halibut with 2 and up to even 10 %; mackerel, 2 to 9 %; mullet, 2½ %. (*c*) Those with less than 2 %, among which are cod, haddock, and whiting.

In estimating the physiological and commercial value of fish as a food one has to remember the very large amount of useless matter in the form of skin and bones which most fishes contain. This may amount to as much as 70 % of the fish as sold to the consumer, and may be quite 35 %, even when served at table. The protein in fish contains more gelatine than does the protein in meat. Fish, then, with all its merits, is not altogether an economical form of protein food, though the cheaper varieties of fishes offer a considerable amount of nutriment for a small sum. Indeed, one authority maintains that the underrated herring 'offers the largest amount of nutriment for a given sum of any animal food, two herrings containing as much animal protein as need enter the daily dietary of an ordinary working man.'

It used to be thought that fish has some special value as a brain food, so that thinkers, politicians, and the clergy were urged to consume it. As a matter of scientific fact there is no foundation whatever for this opinion. It was founded on the supposition that phosphorus is necessary to thought, and that fish contain a lot of that element.

Shell Fish are very popular in this country as delicacies. Both lobster and crab (their composition is practically the same) have flesh which is dense and coarse, and very indigestible. Crab and lobster, though crab less than lobster, have a tendency to contain irritants, and even

active poisons, in their flesh; they should therefore be eaten with great caution, even when quite fresh. Oysters are a very acceptable form of food to most people. When taken raw they are easily digested, but their value as nutriment is not high. The great objection to oysters is their liability to harbour the germs of typhoid fever in a peculiarly virulent form. When thoroughly cooked, however, their dangerousness disappears. English oysters are as a rule moderately safe if taken raw, but it is never wise to eat them outside the British Isles. Mussels are even more to be suspected than oysters. The wise will eschew them; especially in France.

MEAT EXTRACTS.

Medical writers have for long exposed the fallacy that beef-tea and meat extracts generally are nutritious. Soups may, of course, be rendered nutritious by the addition of vegetable and other valuable ingredients, as with pea-soup and soups containing milk and its derivatives; but the ordinary beef-tea or clear soup is little more than an agreeable stimulant.

Vegetable Foods

So much, then, for the food-stuffs which derive from the animal kingdom; the chief characteristics of which, excluding milk, we have seen to be density of substance with richness in protein and fat, associated with relative poverty in carbohydrate. In the vegetable kingdom, which we are about to consider, we find the contrary characteristics, namely, compressibility associated with richness in carbohydrate and relative poverty in protein. The most striking feature in the composition of vegetable food-stuffs is the large quantity of water which they contain. In the case of green vegetables and most fruits, water accounts for more than 90% of the food in its fresh state. This means that a cabbage is really a more watery form of food than milk, which contains but 87% of water. Turnips contain 90% of water; carrots, 86·5%; tomatoes, 91%; watercress, 93%; and cucumber, 95%. In this matter fruits are even more surprising; thus we find a strawberry to contain 89% of water, with only 5% carbohydrate; an apple 82% water; a peach 88%; an orange 86%; and a lemon 89%.

It will thus be seen that the food-stuffs with which Nature presents us are all very dilute. Even milk, which, inasmuch as it contains all the ingredients of a perfect diet, may be regarded as concentrated food, contains nevertheless as much as 87% of water. Attempts are constantly being made to counteract this element of dilution in foods with the object of reducing their bulk. These attempts have not so far

been very successful; and this is fortunate, because their bulkiness or dilution is a great bulwark against over-eating. It is all too easy to over-eat on concentrated stimulating foods, such as roast beef and pickles, but it is almost impossible to over-eat on green vegetables and fruits, even when these are reinforced by bread, butter, cheese, and beer.

CEREALS, BREAD, ETC.

In the vegetable kingdom the most important class, dietetically, is that of the cereals, because it is from them that bread is derived. The cereals include wheat, oats, maize, and rice, all of which conform to the standards of a complete food in the sense that the proximate principles of proteins, carbohydrates, fats, and salts are fairly well represented in each of them. The carbohydrate content in the form of starch is, however, in each case in considerable excess. They are complete, but unbalanced, as may be seen clearly in the following table:

	Water	*Protein*	*Fat*	*Carbo-hydrate*	*Mineral*
	%	%	%	%	%
WHEAT .	12	11	1·7	71·2	1·9
OATS .	10	10·9	4·5	59·1	3·5
MAIZE .	12·5	9·7	5·4	68·9	1·8
RICE .	12	7·2	2·0	76·0	1·0

Of these, in civilized countries, wheat is by far the most important, because it is from wheaten flour that bread, 'the staff of life,' is produced. Next in importance to British people, especially in the north of England and Scotland, come oats, because of the large amount of oatmeal there consumed in the form of porridge and scones. Rice, though a favourite food, especially in the East, is of relatively poor nutritive value. It is, however, very easy of digestion. Maize is little used in England as human food, but in America it forms a staple article of diet; and, since the potato famine in Ireland in 1848, it is much used in that distressful country, chiefly in the form of a sort of porridge known as stirabout.

As has been said, by far the most important food which is made from wheat is bread. Unleavened bread is made of wheaten flour mixed with water and salt, and then baked. It is not much used in this country because it is extremely hard, but among some races it is the main article of diet. Leavened bread is bread which has been rendered light and spongy by the action of gas, mainly carbonic acid gas, produced within it by the fermentation of yeast or by chemical action. The yeast generally used in the making of bread is a living plant which, when allowed to grow on a suitable soil, such as sugar, multiplies rapidly.

In the process of its growth it splits up the sugar into alcohol and carbonic acid, and it is the latter substance which confers upon bread its lightness and sponginess.

The process of bread-making varies much in different parts of the country. The usual proportion is three-quarters of a pound of flour to a quarter of a pint of water. Aerated bread is made without yeast; it owes its lightness to the presence of carbonic acid gas which is prepared separately and forced under pressure into the dough. There is consequently no fermentation process, and no danger of the bread becoming 'sour,' as it is called.

Baking powders are much used in the baking of bread and cakes. They consist of chemical substances which, when moistened with water, give off carbonic acid gas. They are mixed with flour and the other ingredients, so that the liberated gas may permeate the dough and confer upon it the required sponginess.

'Fancy' breads are usually made from pure wheat flour. Milk is often used to mix with the flour instead of water; thus adding to the nutritive value of the bread. Ordinary white bread is made from baker's flour; 'household bread' is made from standard flour, which is cream coloured. Wholemeal bread or brown bread contains all the component parts of the white, with the addition of the bran. For this reason brown bread is richer in minerals and fat than is white bread.

A good deal of controversy has raged around the respective merits of white bread and brown bread. There was at one time a strong prejudice in favour of white bread, but it is now generally realized that brown bread is more economical, inasmuch as it contains more protein and minerals, and is richer in vitamins than white bread. This no doubt is a very important matter to those who depend largely upon bread for their sustenance, and for growing children; but for the majority of well-to-do people there is very little advantage in brown bread over white except that brown bread supplies more roughage, and is, therefore, better for those who are troubled with constipation. Many people, too, prefer the flavour of brown bread.

Bread is one of the most nutritious of all food-stuffs; but, although it contains most of the essential constituents of food, it is by no means a complete diet in itself. It is notably deficient in protein and fat, which supplies the reason for the practice, almost universal among civilized people, of supplementing bread with butter, cheese, and other milk derivatives.

Of other wheat preparations, the best known are semolina, macaroni, and vermicelli. When added to any of the fat-forming foods, such as milk, eggs, or cheese, and well cooked, they make very acceptable articles of diet.

The various biscuits are made of a mixture of flour and water, and

consist largely of carbohydrates. Some varieties contain sugar, butter, and flavouring substances. Some are lightened by the use of baking powder. Those which consist of wholemeal contain a larger quantity of protein than do the ordinary variety made of white flour. Biscuits are thoroughly well baked, and thus contain very little water. They are nutritious and digestible, probably because their hardness and dryness compels them to be well masticated in the mouth, and thus completely mixed with saliva.

Rusks are made of wheaten dough, to which sugar, butter, and milk are added. They are baked twice and then dried.

Oats, which are much used in some parts of the country, notably in Scotland, Ireland, and Wales, in the form of porridge and oatcakes, usually contain a greater amount of nutritious material than any other cereal. The outer covering or husk consists almost entirely of indigestible cellulose, and is firmly attached to the kernel so that its complete removal is not an easy matter. In the process of grinding, particles of cellulose are left in the meal, which is consequently more stimulating to the intestines than is wheatmeal. Some people complain that oatmeal is too 'heating' for them. There certainly seems to be some ground for this complaint, for skin eruptions of various kinds are found to follow its use by predisposed people at certain times of the year. It is said that oatmeal is one of the few vegetable foods which contain appreciable amounts of purin bodies, which are often supposed to be the cause of gout; but there is probably a good deal of exaggeration in this statement. Oatmeal was, until recently, obtained altogether by grinding. Recently, however, rolling has been introduced into its preparation. The great pressure to which the grains are subjected by this new process flattens the grains out, so that they are more easily softened by cooking.

Groats are oats from which the husk has been entirely removed.

Maize or Indian corn is not very much used in England. It is, however, as has been said, the staple diet of South America, and is much used in the United States, South Africa, and Ireland. In the preparation of corn-meal the germ and husk are removed, and the grain is ground to various degrees of fineness. The meal is then used in the form of porridge and otherwise. The so-called johnny-cakes of the United States are made of unleavened, coarse corn-meal, and resemble the *tortillas* of South America.

Hominy is maize which has been split and broken into fragments. It is made into puddings or porridge.

Cornflour consists almost entirely of carbohydrates in the form of starch. It is prepared from maize by a process of washing, in which the starch is separated from the protein and fat.

Maize is a food of great nutritive value. An American writer says

that with a diet of little else but maize, bread, and pork, the workmen of many of the United States are capable of enduring the greatest fatigue, and performing an enormous amount of physical labour.

Barley is not much used nowadays as an article of diet. Barley-meal was formerly the chief means of sustenance amongst the labouring classes in England, but it has in late years been almost entirely replaced by wheat and its preparations. 'Pearl barley' and 'patent barley' are the two forms in which it is now taken. Pearl barley consists of the kernel only, the husk being removed. The 'patent' variety is made by grinding the kernel into flour. Barley is used in soups and in making barley-water.

Rye is very much used in Northern Europe, especially by the Germans. Rye bread is moist, heavy, and very dark in colour. It is digestible, but, to most British tastes, not very palatable.

Rice is rich in starch, but poor in protein and fat. It is very digestible and well absorbed, leaving a very small amount of residue. In this country it is chiefly used for puddings, and is supplemented with milk, eggs, and cheese. In India and other parts of the East, millions of people live almost exclusively upon it, accompanied by various sauces and condiments. It is often combined with food made from other members of the vegetable kingdom which are richer in protein and fat. Polished rice is the grain which has been divested of the grey-coloured skin which normally envelopes the endosperm. This polished rice, though whiter and of 'better appearance,' is of much less value as a food-stuff; the unpolished variety should always be chosen.

Tapioca and sago are starchy foods which to some extent take the place of cereals. Tapioca is made from the root of a South American plant, and is prepared by washing the grated root and collecting the starch which has settled in the washings. It is dried on hot plates, and in the process most of the grains are ruptured. Sago is made from the pith of the sago palm. It also consists mainly of starch, and resembles tapioca in its properties.

PULSES.

Next in importance to the cereals come the pulses, namely, peas, beans, and lentils. They are relatively rich in protein and carbohydrate, but poor in fat. This supplies the reason for their association with bacon and olive oil in ordinary dishes. They are said to be rather indigestible even when thoroughly cooked—an altogether undeserved reputation. When quite young they are digestible even raw, but all too rarely, their delicacy is wasted through being left until they are hard and harsh. Green peas contain about 15% of carbohydrate. They are best cooked by steaming. Beans are of many kinds. When green, French or kidney beans are eaten with the pod.

They may be eaten raw, but when old and stringy they require in that case very thorough mastication. Broad beans are too much neglected in this country. They are very nutritious, and when properly prepared by cooking are very digestible. They contain no less than 25 to 50% of carbohydrates.

ROOTS AND TUBERS.

Roots and tubers, which are laid under contribution for human food, may be regarded as reserves of nourishment intended for the use of the adult plant, just as seeds are reserves for the infant plant. During the spacious days of spring and early summer the plant lays by what it does not require, so that it can utilize the store later on; and this store usually consists mainly of starch. There is also a certain content of protein and fat, but relatively little. Of the tubers the most important is the potato. This was introduced into England about three hundred years ago, and since that time has steadily increased in popular favour, until it is now one of the most valuable of our staple articles of diet. This is especially true of Ireland. The starch grain is of a specially large size, and the tuber is used in commerce because of its richness in this factor. The digestibility of potatoes depends largely upon the manner in which they are cooked. A floury potato is more digestible than a waxy potato, and mashed potatoes are more easily digestible than are potatoes which are fried in fat. A boiled potato takes two to two and a half hours for its thorough digestion. Young potatoes require a great deal of mastication for their thorough digestion. Potatoes are unsuitable for use as the only means of nourishment, and should be supplemented by foods which contain protein and fat. The practice in Ireland of using as supplemental matter buttermilk and herrings is dietetically perfectly sound. The most important mineral ingredients in potatoes are the salts of potash, and potatoes are one of the chief sources from which we obtain our supply of these necessary salts. The ordinary potato contains 78·5% of water and 18% of starch. Its salts make up nearly the whole of the remaining $3\frac{1}{2}$%.

The next most important root is the turnip. This consists largely of water, with a small amount of carbohydrate in the form of pectin—a jelly-forming substance—and a certain amount of mineral salts. It contains no less than 90·3% of water. It is almost incredible that a root which seems so firm and uncompromising as a turnip should contain so little solid matter. Its carbohydrate content is only 5%, and its protein content under 1%. The carbohydrate in the turnip is not in the form of starch. In view of these facts it is obvious that the turnip can never be regarded as an important source of nutriment.

The carrot is a much more interesting root than the turnip. It is by far the more nutritious of the two, owing to its richness in sugar—

nearly 10%, mostly in the form of fruit sugar. It does not contain much protein, but its mineral salts, which are present mainly as potash, are of considerable value. A carrot when young is very digestible, even eaten raw. It contains 86·5% of water. Young carrots constitute a very good form of food, if it is remembered that they contain only a very small proportion of protein, and so need supplementing.

Beetroot is a valuable food-stuff in the same way as the carrot is, namely, owing to the large amount of sugar it contains.

Parsnips come into the same category as carrots. They are fairly rich in starch and sugar, but lose a good deal in the process of cooking.

Jerusalem artichokes resemble turnips in containing no starch. They contain a little sugar and about 2% of a peculiar carbohydrate, inulin, about which little known.

The onion has a high value as a flavouring agent; though its nutrition value is not great.

It used to be thought that roots and tubers were of less value than other foods because they had not been exposed to the influence of the sun's rays. This is now known to be a mistaken view. Most of them contain vitamins which follow the usual rule of being either destroyed or profoundly modified by prolonged boiling or cooking.

GREEN VEGETABLES.

We now come to the vegetables which are grown above ground. Green vegetables consist chiefly of water, with a very small amount of protein and carbohydrate. Their dietetic value is due to the facts that they are rich in minerals, especially in potassium and iron, and that they are a very important source of vitamins.

A cabbage, for example, contains 89·6% of water, 5·8% of carbohydrates, and 1% of protein. From this it will be seen that the amount of solid nourishment in a cabbage is very small. The effect of cooking upon green vegetables is still further to reduce their already poor stock of nutriment; for by cooking they gain water and lose part of their carbohydrate and protein, and a good deal of their mineral matter. For example, the cabbage loses by boiling 30% of its total solids, this percentage being made up of about half of the total mineral matter, one-third of the carbohydrates, and 5% of the protein.

Cauliflower is a useful and attractive form of vegetable. It is very easily digested. The green tops of turnips and other root vegetables should not be thrown away, but should be utilized for cooking in the same way as cabbages.

Spinach is one of the most useful of all vegetables.

Endive, lettuce, mustard and cress, and other green vegetables used in salads, and eaten in the raw state, are valuable on account of their vitamin content.

Tomatoes consist chiefly of water, with a certain amount of carbohydrate. It used to be thought that they contained oxalic acid in undesirable quantities, but this is now known not to be the case, and gouty people may eat them with impunity. They are very easily digested, and are a valuable source of vitamins.

Mushrooms, contrary to the popular idea, are not very nutritious. They contain, in addition to water, a certain proportion of cellulose, a little nitrogenous matter, sugar, salts, and various substances to which they owe their flavour.

FRUITS.

Fruits are, in this country, eaten because of their refreshing qualities and their pleasant flavour, rather than for any great nutritive value which they may be thought to possess. Most fruits consist of a very large percentage of water. The strawberry, for example, contains 89%; the apple, 82%; the peach, 88%; the greengage, 80%; the gooseberry, 86%; the blackberry, 88%; the water-melon, 92%; and the lemon, 89%. It is curious that grapes, which one would expect to have a large fluid content, have only 79%. Bananas have but 74%.

Much of the nutritive and stimulating value of fruits is said to reside in their skins, and people who are convinced fruitarians always eat their fruit as Nature has presented it to us. According to their view the practice of peeling fruit is undesirable. Bought fruits should, however, be carefully wiped before eating. The most nutritious fruits, bananas, figs, dates, and raisins, are not indigenous in this country. Bananas contain both carbohydrates and protein, and may therefore be regarded as a complete food, and many native races subsist on them almost entirely. Figs contain a large quantity of sugar, and a certain amount of protein. They are nutritious, and are said to compare in this respect favourably with an equal weight of bread. Dates are rich in sugar, and are the chief article of diet in Egypt. Raisins are, of course, dried grapes. They contain a certain amount of sugar, with a little protein and vegetable acids and salts. They are a very good form of food. Almonds and raisins, in right proportion, do indeed furnish an almost complete theoretic human dietary.

NUTS.

Nuts, unlike most of the juicy fruits, constitute something very near to a complete food. Bulk for bulk, they are said to be amongst the most nutritive foods which we possess. They contain 15 to 20% of protein, 50 to 60% of fat, 9 to 10% of carbohydrate, 1% of mineral matter, and 5% of water. Owing to their richness in fat, nuts are said

to be indigestible, but this they need not be if they are properly masticated before they are swallowed.

The chestnut has been held to be the most valuable of all the nuts from the point of view of diet. This is on account of its containing a high proportion of carbohydrates along with protein and fat. There is a saying that if you give a Sicilian a goat and a chestnut tree he will do no more work all his life.

Dietetic Principles

In order to enable the reader to take an intelligent interest in the scientific side of dietetics it has been thought desirable to enter into some slight detail regarding the chemistry of food values: it should, however, be clearly understood that a healthy person should not concern himself too minutely about such matters as the composition of his food in proteins, calories, vitamins, etc. When a rational dietary, in consonance with a person's personal and physiological predilections, has been decided upon, it should, as a matter of routine, be adhered to. But there ought in any case to be plenty of variety in this routine scheme, and a definite departure therefrom, every now and then, is not only harmless, but positively beneficial. Such departures may be either in the direction of fasting or of full eating. People like to celebrate great occasions by plethoric banquets; and such banquets — and this includes Christmas dinners — have a certain scientific sanction. Provided that it is not too frequent, feasting is useful in keeping the digestive organs in training, as it were. It prevents these organs from getting into a groove in which they might incline to become priggish and reject anything which was unusual. The trouble, no doubt, is that the occasional feast seems to do so much good in raising, not only the tone of the digestive organs, but the general morale, that the individual is likely to conclude that feasting should be his rule and moderation his exception. And, just as occasional—very occasional—feasting does good, so does occasional fasting.

FASTING.

Fasting is by no means a popular hygienic measure, but it is a very efficacious one. The notion that strength must be kept up at all hazards, and that this can only be effected by grim and conscientious over-feeding, is so firmly fixed in the popular mind that any suggestion of fasting is received with derision. And yet it is the simplest and cheapest and least dangerous method of redressing a digestive balance that could be imagined.

The method of going about a fast is not the simple one of abstaining

from food for the prescribed time; it requires a little preparation and a little management. It is fully described in a later section, but a short synopsis may be appropriate here. It is important so to arrange matters that the intestines, especially the large bowel, should be empty before the fast begins. This is best ensured by taking a dose of Epsom salts or Glauber's salts, or any other simple aperient, such as castor oil. When the bowels have acted thoroughly, thus preventing any risk of the reabsorption of effete matters, the fast begins. Assuming that it is to last three days, the patient must make up his mind to take nothing except water (containing perhaps Epsom salts or bicarbonate of soda) for the prescribed period. If he yields to the persuasion of his wife to try a little beef-tea (to keep up his strength) he will be punished by a craving for food; whereas, if he takes nothing, the slight desire for food at the usual meal-times on the first day very soon passes off. The desire on the second day is definitely less, and on the third day the desire has almost disappeared. Except for somnolence, which is often a prominent feature, especially at the usual meal-times, the patient feels much as normal, except that his brain is more active. If he is very sorry for himself he can remain in bed, and may derive comfort from hot baths and gentle massage, but as a rule there is no reason why he should not follow his usual vocation. If he does this he is the more likely to find his discipline tolerable. The fast should be broken at its end by a very small meal, such as a lightly boiled egg and some thin bread and butter. Fasts of this kind are very useful to people whose work compels them to eat more than they really wish to do, and very much more than they require. It is not, of course, always necessary to fast for three days. Fasts of lesser duration will frequently restore a digestive balance to normal; but whatever the duration, whether more than three days or less, the technique above described should be carefully observed. People who are afraid to undertake a fast lest something terrible should befall them, should accustom themselves to the theory and practice by missing a meal every now and again. They will then be able to convince themselves that fasting is not only perfectly safe, but is in a sense rather an agreeable discipline giving what the Americans call an uplift. The best meal to miss for this trial purpose is certainly the midday meal. The result of this 'missing' in some cases has been the total abolition of luncheon, a change the success of which, in the preservation of energy, has surprised many.

INDIGESTION AND OBESITY.

It cannot be too frequently repeated that the act of ingestion, the conversion of crude food-stuffs into material capable of digestion, the digestive acts, and the ultimate absorption into the blood-stream, make up a highly complicated series of processes which demands for its

successful performance an enormous amount of energy; hence the habit of the 'siesta' in some countries, and hence the heaviness and drowsiness of those who eat largely and do not abandon themselves to a siesta. The blood which is wanted in the brain is otherwise occupied. It is engaged upon the physiologically more important task of the disposal of food. It is frequently said that most people eat too much. This is largely true of sedentary folks, who often eat, day after day, an amount of stimulating meat and saccharine food which would more than suffice for a man doing hard physical labour during eight strenuous hours daily. The most common result of this over-eating, both in quantity and quality (it is the quality which is responsible for the quantity; no fruitarian over-eats), is indigestion in some form. In comparatively healthy people, while still young, indigestion is liable to assume forms which are slight in degree and difficult of recognition, so that the over-eating continues until it shows itself in middle life in the form of obesity. Here it is necessary to say in parenthesis that not all forms of obesity are due to over-eating. Most cases of corpulence are certainly caused by over-indulgence in the pleasures of the table, but there are some instances which are due entirely to the defective action of some of the endocrine glands, notably the thyroid, the pituitary, and the ovaries. Examples of obesity due to such causes may be observed in women at the change of life.

When obesity is due to dietetic causes the fault not infrequently lies, as has been said, not so much in excess in quantity as unsuitability in quality, though in many cases the two are combined. It is always well in the first instance to reduce the gross intake. If, for example, afternoon tea with scones and cake and other starchy and saccharine material is taken, then that meal should be deleted from the schedule. It is well to inquire further as to what may be called illicit intakes, such, for example, as chocolates and other sweets between meals. It is astonishing to find how many sensible educated people will, while adhering more or less closely to a slimming diet so far as regular meals are concerned, nevertheless eat large quantities of chocolates and lollipops between meals, on the plea that these are not on the list of things forbidden.

The various diets which have been recommended for corpulence, from Banting's down to the present day, all agree in a severe limitation of the carbohydrates and fats. The modern view seems to be that the reduction to the point of abolition of the carbohydrates is the most important measure to adopt. Fats are undesirable, so that butter and olive oil should be limited, and cream should be taken in strict moderation only. If, however, the carbohydrates are levelled down to a fixed amount of bread, with a rigid exclusion of all artificial and concentrated sugars, the fear of corpulence need rarely worry us, even though a certain amount of fat be taken. It is to be remembered that obesity

is not merely an artistic matter, but also a pathological one. Insurance companies find that 'overweights' are bad lives, and every experienced surgeon will declare that he dislikes operating on fat folk, they have such poor reaction. The fat man of fifty is a danger to himself. He should set about reducing his weight, and when he has got it to the right level he should struggle to keep it there.

General opinion accords to a moderate degree of obesity the merit of first-class condition, but those who really know are agreed that the longest lived are found among the underweights. Such on the whole would seem to be the considered view of the medical profession. Doctors, nevertheless, still regard a spare figure with suspicion, especially when the weight continues to fall. A light weight which is stationary is part of the make-up of the individual, and should not be interfered with; but a light weight which continues steadily to lose demands investigation. Fat is in a very special sense the food of the nervous system, and those who are seriously worried or overworked use up their stores of fat rapidly, and sometimes disastrously. The best way of dealing dietetically with such cases is by an extra ration of diluted alkalinized milk, with its cream, given between meals. A warm bath at bedtime to encourage sleep is very helpful.

Suitability of Diet

Suitability of diet is, above all things, an individual matter. An intelligent person learns by degrees, and often by bitter experience, the kinds of food which he can best tolerate, and if he is wise he will seek to ascertain at an early age what is best for him in the matter of quantity. The standards which obtain in this matter at the present day are clearly excessive, and it is certainly on the revision of those standards in the direction of moderation that the future dietetic welfare of the nation will depend. We have become so accustomed to eat large, very unnecessarily large quantities of cooked and concentrated foods, that we regard ourselves as ill-used when asked to go back to natural foods and live simply. As in the matters of dress, exercise, and other matters of personal hygiene, so in the all-important matter of food, the nearer we can get to the simple, physiological, animal side of life, while preserving the essentials of civilized amenities, the more likely are we to escape the penalties of the arrogant assumption that we know better than Nature.

It is, for example, a great pity that the cooking-stove should dominate our attitude to the vegetable kingdom. That cookery profoundly modifies the composition of vegetable food-stuffs is everywhere admitted, and it is certain that the modification is not in all cases desirable. It is,

after all, a mere matter of fashion or custom that we should cook all green vegetables instead of using them raw, as in salads; young cabbages, young carrots, peas, tomatoes, spinach, and other vegetables are not only palatable and nutritious, but they offer a very large variety of the sort of food which, judging by the profusion with which Nature presents them, we are intended to consume in the appropriate season. It is the same with fruits. Many people deem it necessary to stew all fruits, lest, taken raw, they should cause indigestion. There is in reality no reason to believe that ripe fruit will cause indigestion. Unripe fruit is liable to disagree with delicate stomachs on account of the crude acids which it contains, but except in the rare cases of people who have idiosyncrasies in the matter of certain fruits (such as strawberries), properly matured fresh fruits are not only harmless but constitute a wholesome and refreshing form of food, whose nutrient value is, in the view of some dieteticians, very much higher than their chemical and vitamin composition would lead one to expect. In parenthesis be it said that there seems to be no sanction for the belief that stone fruits, such as plums and peaches, are less digestible than are the stoneless.

An 'Unfired' Dietary

The following is a basic working model of a so-called 'unfired' dietary. The general principle is that only those foods which are uncooked are suitable. This is, however, subject to modifications which will be indicated later. Except for those modifications the general principle of no cooked foods whatever should be adhered to. There remain therefore:

1. '*Dairy produce.*' Eggs, milk, cream, butter, cheese, cream-cheese, honey.

2. *Uncooked vegetables.* (*a*) Lettuce, endive, chicory, mustard and cress, watercress, cucumber, radish, tomato, spring onion, corn salad, dandelion, celery.

(*b*) Carrots, turnips, artichokes, parsnips, sliced very thin or grated.

With these any condiments may be taken. A dressing made with raw eggs, milk, mustard, pepper, salt, oil, and vinegar or lemon juice may be used with advantage.

3. *Uncooked fruits* of all kinds. Apples, pears, bananas, oranges, grapes, strawberries, raspberries, blackberries, peaches, nectarines, green figs. Nuts of all kinds are included. Dried fruits are not very valuable, but there is no objection to figs, prunes, and dates.

4. *Oysters, uncooked, and caviar.*

5. There is no objection to wine or spirits in the very strictest moderation. Tea and coffee in reasonable quantities are harmless.

Among cooked foods the following are permissible:

(*a*) Bread or toast, of stone-milled wholemeal bread if possible.
(*b*) Cooked green vegetables: e.g. green peas, beans, spinach.
(*c*) Eggs in any form.
(*d*) Fish, chicken, and game may be taken occasionally, but never more often than once daily.

No form of butcher's meat is allowed, and sweets and puddings of all kinds are strictly prohibited. A reasonable quantity of brown sugar in tea or coffee is unobjectionable.

From an MS. in the Trinity College Library, Cambridge

A THIRTEENTH-CENTURY DOCTOR'S DISPENSARY

V—GETTING RID OF THE WASTE

THE elimination of waste products is an important part of bodily activity; for, just as with a coal fire faulty ventilation and failure to get rid of the fumes and smoke on the one hand, and imperfect removal of the unburnable ashes on the other, will eventually interfere considerably with the processes of combustion, so with the human furnace gaseous and chemical products and unused debris must be eliminated lest impairment of functional efficiency should result. The *nature of these waste products* must first be considered.

DIGESTION AND ABSORPTION

The processes of digestion and absorption have as their aim the supply of nutriment to the cells of the body, to repair wear and tear, and to secure the intricate chemical activity which enables each cell to carry out its particular function. The results of these chemical processes vary according to the type of food-stuff concerned. The carbohydrates (sugar and starches) are eventually converted into water and carbonic acid gas (carbon dioxide) in the presence of a supply of oxygen brought by the blood. Fats likewise are completely burnt up, if the balance of other substances (principally sugar) is correct, into water and carbonic acid gas. The proteins (nitrogen-containing substances) are broken down in the digestive processes to comparatively simple chemicals, and the ultimate fate may either be that these are built up again into more complex constituents of the cells, or broken down eventually into a substance known as urea. Water and carbonic acid gas are also formed. Certain special forms of protein finish up as uric acid, but this is a very minor process compared with the production of urea. At the same time as these chemical consequences are resulting from the combustion of food-stuffs, the cells of the body may be disintegrating and contributing exactly the same variety of waste products, all of which are transported away from the cells by the tissue-fluids and blood-stream.

These are the major events leading up to the manufacture of waste, but there are others. The mineral salts of the body have also chemical reactions in the cells, partly concerned with the maintenance of the alkalinity of the blood and tissues at a constant level. If, for example, a large dose of acid is taken by the mouth the body at once attempts to neutralize any possible adverse effect of this on the tissues by calling

on reserves in the blood, and the result is certain waste products, which must be eliminated in getting the acid out of the body again. There are certain minerals which when taken in with the diet are eliminated daily in almost the same quantity as that in which they were taken in. Whether iron, for example, which is sometimes found to be behaving in this way, is being utilized and at once discarded, or whether its presence in the body is essential to permit other chemicals to work, is not altogether clear. It forms, in any case, one of the waste products to be eliminated.

The body is not wasteful in dealing with end-products, and in certain instances makes use of them before finally getting rid of them. For example, the carbonic acid gas is an important regulator of the breathing. Bile, which is largely formed out of broken-down red blood corpuscles, is an important adjunct to certain aspects of the digestion of food in the intestines before it is eventually discarded. A very large part of the solid matter finally eliminated by the alimentary canal consists of bacteria which have taken part in various processes of breaking-down food in the upper parts of the intestinal tract. The waste products eliminated by the bowel consist largely of water, and solids form only about one-fifth of the whole bulk. These are mainly cells and micro-organisms as already mentioned, as well as unabsorbed food, the residue of the digestive juices, bile, certain minerals (iron, magnesium, and calcium), products of decomposition and undigested food, such as tough 'elastic' tissue, 'keratin' (as found in nails), cellulose (the indigestible framework of starchy foods), and a certain amount of fat.

Processes of Elimination

The routes by which elimination is accomplished are through the lungs, skin, kidneys, and bowel. To a very minute extent the tears and saliva may aid in elimination when these secretions are lost to the body.

ELIMINATION THROUGH THE LUNGS.

Through the lungs the body gets rid of carbonic acid gas and water. The air taken into the lungs contains only minute quantities of carbonic acid gas (or carbon dioxide), about four parts per ten thousand. The air issuing from the mouth or nose when breath is expired contains about one hundred times as much. Even so, each breath of an adult gets rid only of just over one cubic inch of this gas, but as this process is continued day and night with every one of the twenty breaths per minute the quantity eliminated in the twenty-four hours is considerable. Water also is eliminated at each breath; that the inspired atmospheric

air, containing little or no 'water vapour' according to the conditions in which the individual is breathing, is expired fully charged with water-vapour, can be easily demonstrated by the 'steaming' produced on a cold surface, such as a mirror. Carbonic acid gas is transported from the tissues to the heart, through the venous blood, and pumped through the blood-vessels coursing through the lungs by the right side of the heart. In the lungs the fine capillaries enable the blood and the external air to be very close together, separated only by a thin layer of cells. Carbonic acid gas, held partly in solution, but mostly in loose chemical combination, passes from the blood into the air-spaces where the amount of this gas, as already explained, contained in the atmospheric air is very small. If the process could be imagined as arrested for a space of time the amount of carbonic acid gas on each side of the single layer of cells would become equal. Actually the blood is moving, and the air is moving in and out of the air-spaces of the lungs, so that this ideal state may not be altogether attained, although investigations show how very nearly the body achieves this aim.

The depth and rate of the movements of respiration are in part controlled by the amount of carbonic acid gas in the blood. In exercise, for example, the activity of the muscles leads to a greater production of this gas, and as a result of the increased amount in the blood reaching a certain part of the nervous system impulses are sent to the muscles which move the chest and to the diaphragm, with the result that breathing becomes deeper and quicker. The increased quantity of carbonic acid gas in the lungs, in the instance quoted, is exhaled from the body. Where acid is taken into the body the net result is that less chemicals are available in the blood for soaking up the carbonic acid gas produced in the tissues, so that this gas is increased in quantity in the blood, breathing is increased, and the carbon dioxide itself, when in solution being a weak acid, is eliminated. Meanwhile the safely combined acid has been passed out of the blood-stream by the kidneys as a harmless salt, and the reaction of the blood has been maintained. Poisonous acid substances produced in the body, as in certain disorders, such as diabetes, are dealt with in a similar way.

The effective elimination of carbonic acid gas, as has been explained, depends upon the difference in quantity of this gas on either side of the single layer of cells separating the blood from the air in the depths of the lungs. If the amount of carbonic acid gas in the atmosphere increases there is considerable interference with this. The principles involved in keeping the amount of carbonic acid gas in the atmosphere down to a safe level are grouped under the title of *ventilation*. It has been said above that normal atmospheric air contains only four parts per ten thousand of carbonic acid gas. Every expiration adds to this quantity, and it is commonly stated that when the proportion in a

closed space reaches one part per thousand a feeling of stuffiness is experienced. Actually, when volunteers have been placed in specially constructed chambers, and allowed to breathe concentrations of carbon dioxide gas of this concentration, there have been no unpleasant feelings so long as the temperature and the humidity of the atmosphere were kept from rising. Certain of the symptoms of stuffiness attributed to the concentration of carbon dioxide are due to these other factors. It is generally reckoned that three thousand cubic feet of air are required for each adult per hour in order to prevent the accumulation of carbonic acid gas and moisture from rising too high. (Actually the oxygen requirements of the body are served by very considerably less than this.) It is generally recommended that one thousand cubic feet of space should be allowed for each adult, so that this must be changed three times in the course of an hour to secure healthy breathing. The air must be moving, as this enables the body to get rid of water-vapour ('insensible perspiration,' see below) and heat, but it must not be moving too fast in narrow streams, so to speak, or draughts and areas of irregular cooling will occur. Ventilation is usually secured by means of windows and a fire-place. Air comes in through the windows and passes out up the chimney. Various artificial systems of ventilation have been devised to imitate or improve upon this elementary method.

ELIMINATION THROUGH THE SKIN.

The skin is a much more important organ of elimination than is generally realized. The average amount of perspiration lost through the skin of an adult man each day is over a pint, sometimes as much as a pint and a half, assuming only an ordinary quiet day's activities. Perspiration is 99% water. There is also present a small amount of urea, the end-product of protein digestion as described above, certain fatty acids, and certain salts, chiefly chlorides and phosphates of sodium, and to a less extent of potassium. In disordered conditions of the kidney where urea accumulates in the blood, the amount eliminated through the skin may be so considerably increased that a crystalline deposit is to be found all over the body where sweat glands occur, known to doctors under the descriptive name of 'urea frost.' The sweat glands are coiled tubes situated in the deeper layers of the skin, and connected to the surface by a fine tube which opens at four small orifices. The amount of sweat depends to a large extent upon the quantity of blood circulating in the skin; when the capillary blood-vessels dilate and more blood flows more sweat is produced. There is also a certain amount of control by the nervous system, both as to the amount of blood-flow, and also to a lesser extent by control of the contraction of minute muscle-fibres which surround the sweat glands.

The 'cold perspiration' which occurs after a fright is due purely to nervous causes, and represents the sudden squeezing out of sweat by these minute muscles. The degree of dilatation of the blood-vessels of the skin depends upon the control of the heat-regulating part of the brain. Where more 'heat' has been formed in the body, either by the chemical changes occurring in muscular activity, or by the 'fever' of disease, one method available of getting rid of the heat is through the skin. Actually a proportion of the total fluid proceeding through the sweat glands evaporates at once from the surface. This is known as the 'insensible' perspiration, and the water-vapour formed in this way at the surface of the skin means a definite loss of heat from the body. Over and above this is the 'sensible' perspiration which remains behind and, unless in great excess, is usually absorbed by clothing.

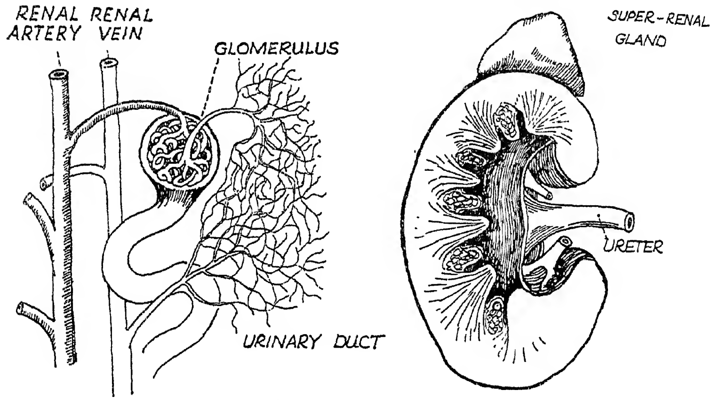
The total amount of fluid eliminated through the skin roughly varies inversely with that lost by other routes. For example, if diarrhoea is present, and fluid is being eliminated in great excess by the bowel, the amount of perspiration is greatly diminished and the skin feels very dry. If the kidneys are diseased, so that their power of fluid elimination is diminished, the amount of perspiration is greatly increased. In hot weather when the blood-vessels of the skin are dilated, and more blood is flowing through them, the amount of perspiration increases, and the amount of water passed out by the kidneys diminishes.

Since the skin is such an important source of elimination of fluid, care must be taken to ensure that its function shall not be impaired. Adequate toilet of the skin will remove accumulated grease and dirt which might considerably interfere with the loss of perspiration. If the atmosphere in which the body exists is so highly charged with water-vapour that insensible perspiration is prevented serious consequences may arise. Adequate ventilation, as mentioned above, ensures that the air is moving sufficiently to carry off water-vapour formed by this form of perspiration. In tropical climates it is the moist heat which proves most trying to Europeans, since the high degree of humidity prevents adequate loss of heat through the insensible perspiration. Higher degrees of temperatures can be endured as long as the air is dry. Clothing must be designed in all climates to allow the passage of the water-vapour of the insensible perspiration, and to take up the surplus perspiration. Loosely woven fabrics are preferable for this purpose, and closely woven cotton the least satisfactory. The 'airing' of clothes when discarded at night is important, so that the fluid accumulated during the day may evaporate.

ELIMINATION THROUGH THE KIDNEYS.

The kidneys are the most important organs of elimination. Essentially they consist of a series of filtering tubes, in portions of which the

blood is separated from the blind end of a tube by only a single layer of cells. Waste products and water can thus pass out of the blood, and the kidneys play a very important part in maintaining the level of certain substances in the blood. For example, if the amount of sugar present in the blood rises above a definite level this substance is at once passed out through the kidneys until the level in the blood again falls to normal. The kidneys also help to regulate the degree of alkalinity of the

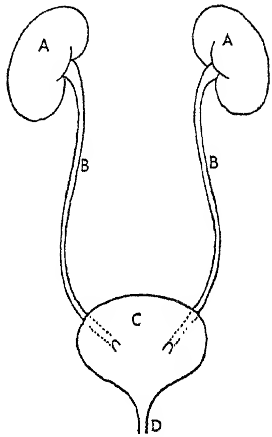


STRUCTURE OF KIDNEY

blood. As already mentioned in connection with the lungs, the taking in of acid or the formation of acid in the body at once sets in motion a chain of chemical processes designed to get rid of what otherwise might prove a dangerous substance. The kidneys aid by eliminating certain acid salts and salts of ammonia. The kidneys also elaborate certain substances in a form more suitable for elimination than that in which they exist in the blood.

The urine, formed in each kidney, passes down a muscular tube, called the ureter, to the bladder, situated behind the bones at the front of the pelvis. There it accumulates until voided down an outlet tube called the urethra. Urine is a pale straw-coloured fluid, consisting of 96% water and the remainder solids. The quantity passed by an adult in the twenty-four hours averages about two and a half pints, but, as mentioned above, this varies with the loss in other ways, being less in the hot weather, when the urine becomes more highly concentrated. Of the solids, half consists of urea, the end-product of digestion of the proteins as already explained. In smaller quantity are other end-products of protein digestion, such as urates. There are also certain salts, sulphates, phosphates, and chlorides of sodium, and potassium. The colouring matter is a special pigment, and in addition the urine contains

a certain amount of dissolved gas, mostly carbon dioxide and a small amount of nitrogen. The concentration of the solids is limited by their several degrees of solubility. Where, for example, more urea than usual has to be eliminated, the amount of urine is increased. This is also seen in diabetes, where the elimination of sugar, owing to the raised level in the blood, is accomplished only by the passage of a larger quantity of urine than normal. After being voided, urine often shows a deposit. This represents crystalline material deposited out of solution, and is frequently an indication that not enough fluid is being taken in by the body. A faint pink colour in such deposits often means the deposition of urates. The addition of hot water promptly dissolves such substances, and is a quick way of proving their harmlessness. Uric acid, the end-product of the chemical processes concerned with a certain type of protein, is normally formed to a slight extent in everybody. If the intake of certain foods (rich meats, port wine, etc.) is excessive, and in certain disturbances of the chemistry of the body, uric acid may be formed in excess—the disorder known as gout. In this case, unusually large amounts of urates (salts of uric acid) are passed in the urine. Abnormal substances getting into the blood-stream may also be eliminated by the kidneys. Thus a colouring matter, called methylene blue, if taken as a pill, passes into the urine.



A. Kidneys C. Bladder
B. Ureters D. Urethra

The exact mode of formation of urine in the kidneys is not altogether clear, although many facts are known. The main effect is one of filtration, and in damaged conditions of the kidneys, important substances, essential to the body, may get through the filters and be lost. As already stated, everything eliminated in this way has to pass out in solution, and an adequate amount of water must be filtered through the kidney to convey the waste products. Where the amount of fluid in the body has become very low (e.g. after very severe diarrhoea, or even after a severe haemorrhage) the kidneys may cease to work—with disastrous consequences. To prevent minor degrees of derangement of the working of the kidneys adequate amounts of fluid must be taken daily.

The formation of urine in the kidneys goes on continuously, day and night, but in healthy people there is a considerable reduction during sleep, so that the quantity passed first thing in the morning is considerably less than that which would be passed after a similar period

of waking activity. Such morning urine is, however, more highly concentrated than that passed during the day. With increasing age, and in certain disorders, this daily variation in the activity of the kidney tends to disappear.

Although urine is more or less continuously passing from the kidneys down the ureters to the bladder, the actual voiding of urine, by the emptying of the bladder, as we all know, only occurs at intervals. The bladder is a hollow muscular organ with two inlets, the ureters, one from each kidney, arranged in an oblique manner to prevent back pressure. There is also one outlet controlled by a circular collection of muscle-fibres known as a sphincter. Once this sphincter is relaxed urine passes freely down the urethra, and is voided. The control of the bladder and sphincter is partly by the voluntary nervous system and partly by the autonomic or involuntary nervous system. In the adult, the mechanism is roughly as follows: As the amount of urine increases, the distended bladder begins to contract rhythmically, and when this reaches a certain degree the desire to pass water is experienced. The individual then raises the pressure in the bladder still further by contracting the diaphragm and so increasing the general pressure within the abdominal cavity. The effect of this is to squeeze the first few drops of urine through the sphincter at the outlet of the bladder into the first part of the urethra (the outlet tube). The entrance of urine into this portion of the urethra initiates a reflex action. The sphincter relaxes, and the bladder contracts steadily until emptied. No further voluntary effort is required, although the process of emptying the bladder may, to a certain extent, be hurried by continuing the increased abdominal pressure. The contraction of the sphincter controlling the outlet of the bladder may be brought about by a voluntary effort so that the outflow of urine is interrupted, but relaxation of this sphincter is not under voluntary control.

Certain points connected with the hygiene of urination arise from this brief account of the mechanism involved. The initiation of the process may be grossly interfered with where disease of the chest or of the abdominal organs prevents the initial raising of the intra-abdominal pressure. In sick patients where there is a possibility of this, steps must be taken to secure that urine does not accumulate in a distended bladder. In other diseased conditions—for example, of the nervous system—the reflex action of the bladder may be prevented from taking place, or the desire for micturition may not be experienced. Regular passing of the urine at fixed intervals is then necessary to avoid dangerous retention. Where there is retention of urine, from any cause, steps must be taken at once to secure expert advice, and pending the arrival of assistance it is recommended that the patient be given warm drinks and be placed in a warm bath.

The description given above refers to the process in an adult. In the baby there is at first no voluntary control, and as soon as the pressure within the bladder reaches a definite level it contracts, forces some urine out through the sphincter (which is not very tightly contracted at this age), and so the process of urination takes place, usually at frequent intervals during day and night. Much may be done, however, to train the baby to control the process. The passage of urine frequently occurs when the napkins have just been removed, and by sitting the baby upon a chamber before and after every feed it is soon possible to produce a 'conditioned' reflex act so that the passage of urine is associated with the chamber. A skilful nurse will often train a baby in this way from the early months of life.

In later childhood, even where this early training has been successful, unsatisfactory control of the bladder arises in certain instances, both during the day and even more commonly during the night. Provided that disease of the kidneys and bladder can be excluded, the daytime loss of control is largely a question of habit, comparable to nail-biting or nose-picking. In other words, there is sometimes something in the child's psychological make-up or environment which interferes with the normal control of parts of the nervous system. Removal of such causes combined with a fresh training of the bladder by insisting upon regular emptying at fixed times by the clock, the period during which the urine is held being gradually prolonged, will usually effect a cure. The loss of nocturnal control, or bed-wetting, is a more complicated problem. Here again psychological causes must undoubtedly be recognized. It is well known that a persistent bed-wetter will often cease to give any trouble if taken into hospital or allowed to sleep with an adult. Other factors, however, come into the problem, such as over-activity of certain parts of the involuntary nervous system. This has recently been shown to be due in some instances to a special hypersensitivity to certain foods, notably the fats obtained from the pig (bacon, lard, etc.). Restriction of fluids towards the end of the day, regular waking at 10 p.m. to pass urine, etc., are all measures which have to be considered in effecting a cure.

ELIMINATION THROUGH THE BOWEL.

The bowel is the last important route of elimination of waste products which must now be considered. It has already been stated that the waste products got rid of in this way consist of unabsorbed food, undigested food, bacteria, the residue of the digestive juices, etc. Normally these substances are present in the last portion of the large bowel as semi-solid 'faeces,' of which, as has already been pointed out, four-fifths are water. The normal colour is brown, due to the presence of altered bile pigment, and the bulk varies greatly according to the

efficiency of digestion and absorption, etc. A normal adult eliminates about six to eight ounces of faeces in twenty-four hours. The large bowel, in which the final formation of faeces takes place, is the chief site of absorption of water, for higher up in the digestive tract the contents are more liquid. Wave-like movements of contraction and relaxation take place, possibly in both directions, certainly in an onward direction, the object of which is a continuous kneading and stirring process to ensure that as much water as possible shall be absorbed. Higher up, in the small bowel, the movement of the contents is a more or less steady onward passage. In the large bowel there is more regulated delay. If a special biscuit containing bismuth (which is opaque to X-rays) is eaten, and its passage followed by means of X-ray examination, it will be found to have reached the last part of the large bowel just over twenty-four hours later. Ordinary food probably takes longer; and faeces passed to-day are derived in great measure from the food of the day before yesterday.

The residue of the contents of the digestive tract is eventually passed on into a large s-shaped loop known as the pelvic colon. Beyond this is the last part of the digestive tube, known as the rectum, the exit from which is guarded by a muscular sphincter. The rectum is normally empty, but as the pelvic colon becomes more and more loaded some faeces pass on and enter the rectum. This causes two things to happen: a definite sensation passes back to the central nervous system, interpreted past the age of infancy as a 'call to stool,' and at the same time the muscle in the walls of the rectum slightly contracts into a sort of braced-up condition. The next part of the process is under voluntary control. As a result of the sensation experienced the individual decides to pass a motion. The pressure within the abdominal cavity is raised by contraction of the diaphragm (as with the beginning of the act of urination), and faeces are forced from the pelvic colon into the rectum in quantity. This hollow muscular tube then begins automatically to contract rhythmically with an onward motion, the sphincter is relaxed, and the faeces are expelled.

Such is the process in the normal, healthy individual. Where the nervous system is seriously disordered, all voluntary control may be lost, and the moment faeces enter the rectum, even in small quantity, they are automatically expelled. This is sometimes called 'false diarrhoea.'

True *diarrhoea* means that the whole process of the movement of the products of digestion down the food canal has been speeded up, and the green colour of the frequent stools of this condition is the normal colour of the intestinal contents higher up the digestive tract. Because of the rapid onward passage of all the contents, there is very little absorption of water, and it has already been mentioned that a serious

loss of fluid may rapidly occur in this way. Diarrhoea means usually the irritation of the wall of the bowel by unsuitable or maldigested food, or by inflammation set up by certain microbes (as in typhoid fever). It is a serious symptom in the young baby, and should not be regarded lightly at any age. Diarrhoea lasting for longer than a day should always lead to the seeking of skilled advice.

The opposite state of affairs is much commoner and usually means that in the absence of any real disease of the nervous system or of the bowel the normal process has been interfered with, and difficulty in the elimination of faeces occurs.

This is known as *constipation*, and this widespread disability of civilization must now be discussed in the light of the description of the normal mechanism given above.

In the first place it is obvious that the contents of the colon (large bowel) may be abnormal. If the diet contains no 'roughage,' that is to say, food that will leave some undigestible residue, the bulk and consistency of the faecal material may not be suitable for the normal onward passage. 'Roughage' is to be found in brown bread, fruit, green vegetables, and salad material in particular. Similarly the daily intake may not include sufficient water, so that by the time the colon has absorbed as much as it can the resulting faeces may be hard and dry. Normally the wall of the colon contributes a certain amount of mucus to lubricate the final passage of faeces, and one type of constipation shows itself by passage of excess of such mucus, evidence of the irritation of the hard faeces on the wall of the bowel. A person who is ill in bed on a light diet may readily become constipated on account of a sudden diminution of the bulk of unabsorbed food, etc., left in the large bowel. These causes of constipation should all be regarded as easily remediable by adjusting the diet or fluid intake, along the lines suggested. No medicines should ever be taken in such instances unless the diet and water intake have been under review. In cases of illness the conditions are different, and *under medical advice* various laxative or purgative drugs may be valuable.

Another type of constipation occurs because the normal 'call to stool' is neglected. With many people the sensation caused by the overflow of faeces from the pelvic colon to the rectum occurs daily at a fixed hour (e.g. after breakfast), and the natural series of events outlined above then takes place. With others, encouraged by the rushing tactics of civilization, the sensation is gradually disregarded. At first this means that the rectum becomes more and more full of faeces until the state of tension of the muscle in its walls can no longer be ignored. Still later in the process of interference with Nature's mechanism, even this part of the reflex act is checked, so that eventually the inflicted individual has destroyed the muscle-tone of the rectum, and its

capability of easy, almost effortless emptying, once the initial filling-up process has begun. Instead of the rectum actively voiding the faeces, all the energy required has to be supplied by increasing the intra-abdominal pressure to force the faeces out of the rectum, a relatively inefficient way of effecting this.

A somewhat similar state of affairs may be present in the young baby. At first the passage of faeces into the rectum is followed by immediate elimination, but after a few weeks some increase of voluntary control can be established, particularly if the mother or nurse responsible attempts to train the child. It is not always easy to secure that the child will carry out the necessary movements to pass faeces from pelvic colon to rectum in sufficient quantity to set up the final stage of elimination. This 'laziness' on the part of the baby may very easily develop into the type of constipation mentioned above.

It is obvious that the cure of constipation of this variety and the prevention of its occurrence in the young are both matters of training and habit. It is not difficult to train the baby to associate the sensation of the chamber applied to the buttocks with the necessity for holding the breath. If the rectum seems reluctant to effect the final elimination, it may be aided by the gentle insertion of a vaselined finger into the entrance into the back passage. This local stimulation is sometimes necessary for a few days until the normal habit is established. The passage of hard, dry motions in the young baby generally means that not sufficient fluid is being taken daily, and drinks of water may have to be increased.

Though the dangers and evils of constipation have sometimes been exaggerated, it is not a healthy state of affairs, and irritation of the bowel may lead in time to serious troubles. The relationship of appendicitis to constipation is probably a close one; while in young children constipation has been thought to be responsible for other acute abdominal catastrophes.

It is therefore important that constipation should be remedied, but as far as possible only along the lines of re-education of the bowel and rectum to perform the natural series of movements. For babies the methods available have already been outlined. For adults they are much the same. Aided in some instances by decreasing doses of suitable medicine, and in all cases by a sensible diet, the sufferer from constipation should make an effort daily at a fixed hour, and at no other time unless a definite call to stool occurs. Massage of the abdominal muscles sometimes helps; while a good time to start the 'cure' is after a holiday, when the body is thoroughly fit. In this way people who have been constipated all their lives can be re-educated to a daily effortless stool.

A word may be said about the general attitude to constipation.

Every individual probably has a routine for the bowel which, in healthy subjects, goes on without any serious thought about it. The happiest answer to the question: 'Are the bowels regular?' would be 'I don't know, I never think about it.' The passage of a motion once a week or even once a fortnight has been recorded in individuals seemingly enjoying perfect health. This is, of course, exceptional, but it shows how elastic the rules of Nature may be. Attempts at securing a daily motion in such individuals by means of purgatives might well spell disaster. Too much straining at stool is likewise wrong. The normal action of the rectum, as has been described above, should be automatic once faeces have been squeezed from the pelvic colon into the rectum. Excessive straining in order to empty the rectum itself implies a faulty mechanism. In not a few instances persons have been found dead with a burst blood-vessel in the brain as a direct result of straining at stool. A 'rupture' may also sometimes be brought about in this way, and for this the position adopted at stool is probably to blame. If lower seats were used in all our lavatories there would be less risk of rupture, as then the legs are well bent up, the thighs almost touching the abdomen, and the weak spots in the folds of the groins well protected.

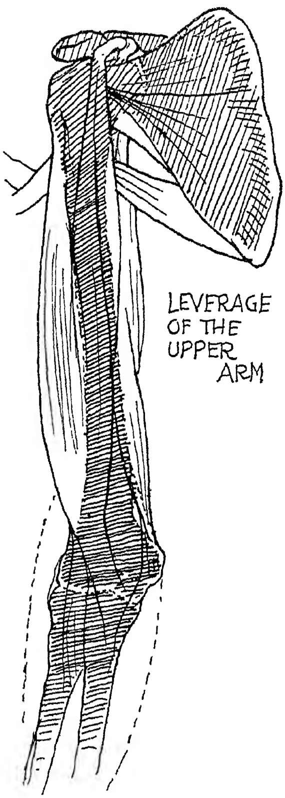
Constipation of long standing probably implies faulty habits, and may be remedied along the lines described. Sudden constipation arising in a previously normal person is quite another matter, and may be the signal of some serious malady. The injudicious use of any purgative on such occasions is dangerous.

MINOR FORMS OF ELIMINATION.

The foregoing contains an account of the usual processes of elimination of waste products. Under unusual circumstances two other very minor routes may play a small part in the eliminatory processes. The *saliva* contains traces of sulphur and calcium, and may cause a loss of these substances to the body. The *tears* contain about two parts per hundred of solids, of which over two-thirds is common salt. It is unlikely that much elimination will take place in this way!

VI—THE MECHANICS OF THE HUMAN BODY: ITS LEVERAGES, MOVEMENTS, AND SUPPORT

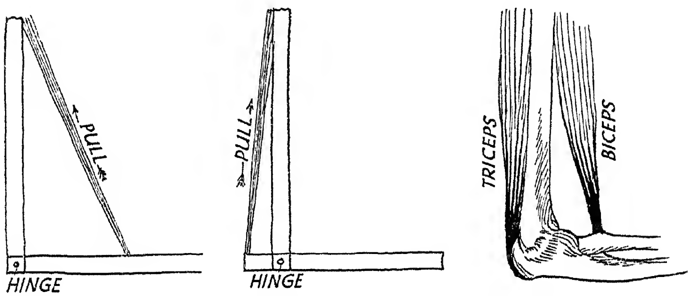
WHEN man adopted the upright position, and began to go about on two feet only, he set himself a problem in mechanics that might puzzle the most expert engineer. Roughly, what he set out to do was this. To upend and keep erect without outside support a column some five or six feet high, so flexible that it would bend nearly double, and could rotate spirally on its axis through half a circle. Projecting from this column were two jointed extensions, which he had to place and maintain at any given angle with the column, lifting and supporting them by means of adjustments within themselves, without other help. The whole of this flexible mechanism was to be balanceable in every possible position on two flat surfaces, each less than twelve inches by four.



The mechanical problem of the quadruped is a very much simpler one. To begin with, stability when supported at more than two points is relatively easy. Balance hardly enters into it. The four limbs carry a bony framework from which all the structure hangs, only the raising of the head and neck presenting any serious difficulty. Where, however, as in the biped, the arm, for example, attached at a single point, has to be lifted, complicated questions arise. The rigid, jointed bones, of which our skeleton is composed, are held together and moved by elastic ropes and bands called muscles and tendons; but the only positive action of these muscles is contraction, with consequent shortening. They pull, but cannot push. Their 'support' is the support of a string, not of a stick. When we say lightly that we 'lift' an arm, we

clearly do not lift it as we lift a parcel from the ground. Although the action is unconscious, we are employing an elaborate system of levers; a system which is operative throughout the whole body, without which we should collapse as does a person in a faint. In fainting, the muscles relax and release the various adjustments of the joints; these give way, and the whole structure tumbles in a heap.

Before it is possible to understand the mechanics of the human body we must grasp the essential principle of the lever, on which principle the whole is based. The levers within the body are of two kinds.

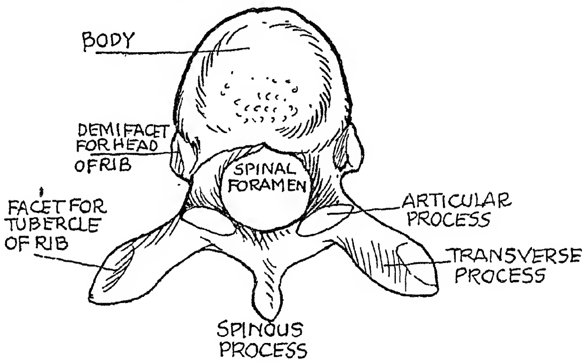


DIAGRAMS OF THE SIMPLE LEVERS OF THE ARM

In the first and simplest we have two arms jointed together, with a cord attached to one at some point within the angle formed by the two arms. When the cord is pulled the free end of the arm rises towards the pull. The greater the space between the hinge where the two arms join and the point of attachment of the cord, the less will be the pull needed to raise the arm. In the second kind the two arms are hinged as before, but not at their extreme ends, and the cord is attached to the end of one, outside the angle formed by them. When tension is applied to this cord the opposite end of the arm will move in a direction away from the pull. The nearer the attachment of the cord to the hinge of the arms, the larger will be the arc described by the free end, but also the stronger will be the pull required. The whole of the work of supporting and moving the human body is done by levers of these two kinds.

The human skeleton is made up of more than two hundred bones, and in the normal person nearly all of these can be moved more or less freely in relation to each other. This movement is the work of the muscles. At the point of apposition of two bones they form what is called a joint, and these, in the human body, differ in their construction. The elbow joint is typical of the simpler of these, and is like the hinge of a door or box, in that it only permits of a straightforward to-and-fro action. The hip and shoulder joints are of the ball-and-socket kind,

permitting much freer motion; the wrist allows of back-and-forth, as well as sideways, movements, but of no rotation; while the simplest of all allow only very limited play, as do those which connect the ends of the ribs with the spine. The surfaces of bone which, in the construction of one of these joints, come together, are lined with an elastic gristle or cartilage, on which these surfaces glide; and round the whole piece of mechanism is a kind of fibrous coat, firmly adherent to the bones, and holding the whole in position. The internal cavity of a joint is lined with a membrane which secretes a fluid lubricant, called the synovial fluid. Joints are further strengthened by the tendons of muscles



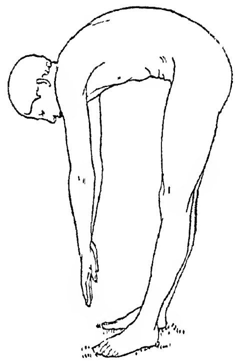
A DORSAL VERTEBRA
From above

passing over them, which act as binders, and by the tough fibrous bands called ligaments, which are attached at their ends to the bones which they support.

The spine, being the most difficult piece of engineering in the whole body, and forming, as it does, the central column round which our whole structure is built, may serve as an example of the mechanisms by which we stand and move. It must be remembered throughout that only bones can support; muscles can but pull.

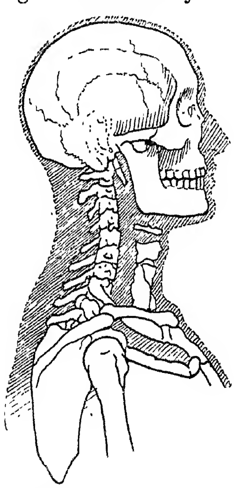
The spine consists of thirty-three bones. Seven of these make up the neck, and are the most freely movable. Below the neck or cervical vertebrae come twelve belonging to the chest, the dorsal vertebrae; five more lie in the loins, the lumbar vertebrae; and five are joined into one bony mass, the sacrum, at the back of the pelvic ring. The four last, the coccyx, are the rudimentary tail; and in the skeleton show as an incurved hook. All these bones are piled one upon the other, and held together by strong muscles and ligaments. They bear the weight of the body, and the lowest are the largest and thickest, as they carry most. The vertebrae are all alike in essential shape, but they vary very much

in their relative proportion of parts according to their uses, and to the attachments of their various muscles. Each has a solid body, the innermost part of the bone, the outer being a kind of ring formed by a transverse knob or process on either side, and a spinous one between them on the outer surface. Within this bony ring the spinal cord is carried right through the body. Smaller processes on the upper and lower surfaces articulate with the neighbouring vertebrae, and between are disks of gristle or cartilage, growing on the surfaces of the bones and permitting their free and gliding movement on one another. The whole series of bones is held together by elastic bands of strong ligament; the bodies by two, extending right from top to bottom of the column, one in front and one behind; and by a series of shorter ones at the sides joining pairs of vertebrae together. Other bands lie in the hollows between the knobs, and link up the spinous processes. In the cervical region this last set join to form the big ligament at the back of the neck.



NORMAL FLEXION OF THE SPINE

If the disks between the vertebrae were absent, the bones would lock upon each other and prevent the movement of the spine. As it is, the whole column of the backbone, except the sacrum and coccyx, is movable; but movement is most free round the waist and loins. A few moments spent in action before a mirror will show this clearly. The thoracic region and the pelvis keep their own shape, only altering their relation to each other; the waist and loins show most of the effect of action.

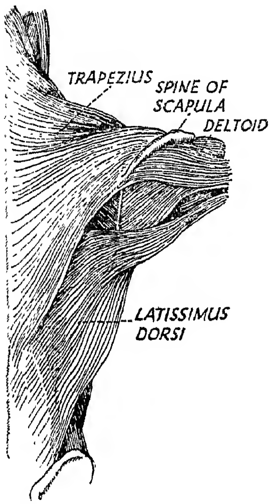


BONES OF THE HEAD AND NECK

The spine is never quite straight when seen from the side, though from the back it should appear absolutely symmetrical. It has four back-and-forward curves, called the normal curves, due almost entirely to differences in the shape and thickness of the intervertebral disks. The movement of the spine is controlled and limited by the locking and interlocking of the vertebrae and their processes. The ribs, which are jointed to the twelve thoracic vertebrae, prevent much movement of that region. A study of the shape of the vertebrae at various parts

of the spine will show why bending forward is easy, whilst backward and sideways movements are mechanically more limited. Rotation or spiral movement is freest in the higher parts, such as the neck, the interlocking transverse processes interfering with it round the loins.

The muscles which hold up and move the spine do not all, of course, do this alone. They act as well on the bones and muscles to which they are attached at their other ends. But, roughly speaking, there are five layers of muscle which act in this way. On the outside the great sheet of muscle which covers the surface of the back, the trapezius and the latissimus dorsi, does its share in holding all together. Then come two which pull from the side processes of the upper vertebrae to the inner and upper edge of the shoulder-blade, the levators. Then two, one on each side, the rhomboids major and minor, which pull from the lower cervical and the five upper dorsal vertebrae to the lower inner edge of the shoulder-blade. Further in still lies the splenius, which attaches the lower part of the great ligament of the neck, the lowest cervical and the upper five dorsal vertebrae to the base of the skull and the knobs of the upper vertebrae. This muscle, when contracted, has a twisting action on the neck and head, those on either side counterbalancing each other and normally acting to keep the head firm and erect. In 'round-shouldered' persons this is slack and weak. Like all the muscles which hold up the spine the splenius has, so to speak, no beginning and no end, as it fans out into separate insertions throughout its length, so as to act on all the vertebrae which come within its sphere of influence.

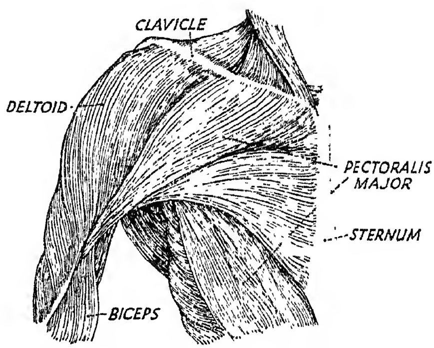


MUSCLES OF THE CHEST AND SHOULDER
Back view

The next muscle in depth is the great erector spinae, which lies right up the back from the sacrum, the hip bones, and the lower vertebrae, to the skull, the upper vertebrae, and the angles of the ribs. Beginning as one mass, it divides as it rises, and pulls on practically all the processes of the vertebrae, holding them together. As every strand of this muscle is capable of separate action, it will be realized how powerful a bending effect on the spine is produced by the drawing together by its means of any two vertebrae or groups of vertebrae. The oblique extensors also extend throughout the length of the spine. They run like a kind of plait from the transverse processes of one vertebra to the middle or

spinous process of another, usually four or five higher up; continuing thus for the whole length of the backbone. These pull downwards and sideways, and can act together or separately. The last and most deeply seated muscle is a flat sheet called the quadrator lumborum, which comes from the upper border of the pelvic mass and the side processes of the four lowest lumbar vertebrae, and ends on the transverse processes of the upper two lumbar vertebrae and the lower edge of the lowest rib. This helps to bind together the whole of this part of the structure.

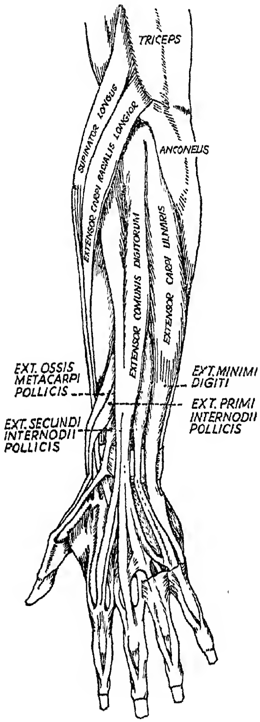
Consideration of the mechanics of the vertebral column will explain a great deal about the choice of exercises designed to strengthen and supple the back and trunk. The spine is of the utmost importance in the maintenance of our health; directly in keeping our movements co-ordinated and strongly and correctly balanced; and indirectly in keeping our organs and our muscular structures in their true relation to one another. It has also a high duty to perform as the guardian of the spinal cord, without which, as has been said, all vital activities become impossible. This complicated piece of machinery, then, when subjected to analysis, is found to consist merely of an elaboration of the simplest levers, set at every kind of angle, and acting singly and in collaboration with each other and with other groups. This collaboration and interaction is the basis of the rhythm which is found in all bodily movement, in greater or less degree.



MUSCLES OF THE CHEST AND SHOULDER
Front view

When we perform a simple action, such as raising a spoon to our mouth, we carry out a blend of several movements. We raise the hand, bend the arm, and so guide the combination of these two actions as to bring the spoon to the desired spot, and then stop it. Clearly if we merely contract the muscles which bend the arm and those which raise the hand, the resulting action will be a jerk; the spoon will fly up, and we shall land its contents in some quite unwished-for place. In order to perform any desired movement, two sets of muscles at least must be brought into play: those which move the limb, and those which check its movement. When we flex the elbow we use both the flexors and the extensors; on the balance of the two pulls depends the rapidity and the force of the action. This balance is found throughout the body,

and in every movement we make, though the delicacy of its adjustment varies enormously. The baby has to develop this adjustment little by little, beginning with movements which to the adult have become unconscious, such as walking and putting food in its mouth. The baby's spoon, at its first attempts, is as often in its ear as in its mouth. It has not yet acquired the knack of using one set of muscles to control the other. So with walking, picking up and putting down objects, and other movements which, later, seem as easy as breathing. The 'awkward,' 'clumsy' person is the one who has never really learnt this muscular knack. He does not truly balance pull against check, so that he uses too much or too little force; either stops his action too soon or carries it on too long. All the manual crafts call for special training of this adjusting power. The watchmaker must be able to count on absolute control of the tiniest movements of his fingers, to apply exactly the amount of power needed, not a fraction more or less. His task is made easier by the delicacy of his work; where force as well as fine adjustment is called for, the control is more difficult. The blacksmith usually has hands and arms finely and very evenly developed; for the work which he does is often not only careful and intricate, but calls for strength as well. His muscles, while strong, must be in perfect balance.



MUSCLES OF THE FOREARM
Back view

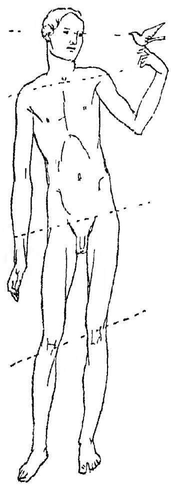
All these complications of action, at first conscious, soon become subconscious with use. The mere hint given by the brain will set going the whole series of pull against pull, movement against check, so that the action seems to us to carry out itself. Sometimes, indeed, it returns to consciousness when some hitch occurs—as when, in typing, a word is spelt incorrectly, the brain will become aware that something is wrong, and will stop the fingers until the fault is found. A whole series of actions of this kind will become linked together by habit, so that one will automatically set all the others going; and circumstances may so govern such a series that it may occur even though the essential original factor be absent. Thus a person accustomed to riding a horse may, when first driving a car, grip the steering-wheel and stiffen his

legs if he sees a dust-bin in the act of falling off a cart beside him, though his intelligence knows quite well that the car is not going to shy. The old chain of reactions is set going by the familiar emergency. So, too, more simply, a person who has been accustomed to use a typewriter with one arrangement of keys, cannot use a machine with its keyboard differently disposed. The gradual adoption of a standard keyboard for all makes of typewriter is due to the recognition of this fact.

Grace in the carriage of the body results from the rhythmic and co-ordinated action of the muscles, without jerky or disconnected movements. So carefully adjusted is the balance of the body and the pull of muscle against muscle, that hardly any movement—the raising of a hand, or the turning of the head—can be performed without some small adaptation of every other part. If we sit in a chair and, without paying special attention to our action, turn the head to look at a person standing behind us, we shall find that every bit of us is moving slightly, following the spiral motion of the neck and head. This 'follow-through' movement is the basis of all graceful and natural action. If we stand upright, with the feet slightly apart, and lightly shift our weight from one foot to the other, we shall feel the swing and settling of all our muscles. The shoulders will alter their slope, the hips will tilt a little, the head will move on the neck. If, in front of a mirror, we keep the body rigid while raising the hand and arm, or turning the head, it will be seen at once how stiff and awkward these movements look.

Graceful muscular balance and flow is sometimes found in natural conjunction with a well-proportioned frame; but it can be cultivated and increased by exercise and training. Though in itself a natural quality, it may also be greatly helped by the formal practice of non-natural rhythms. By this is meant the movement of the body in opposition to its instinctive impulse. When we walk briskly, we swing our arms in a certain relation to the time of our steps. When we turn our shoulders at an angle, we turn our hips at a similar one. When we stretch an arm forward, we put out the foot at the same side. The deliberate practising of the opposite of these and similar impulses greatly aids in acquiring grace and body-control. The human body, by reason of its enormous number of adaptations, differs more in appearance from those of its mammalian relatives than do any of these among themselves. Man has gained an advantage over the quadruped types in his versatility, but he has lost on individual qualities which distinguish many of these poor relations. He is Jack of all trades, but master of few. He is not so swift as the horse, so powerful in grasp as the bear, so nimble as the goat, or so strong as the bull. But the adaptability of his build gives him the dominance over these other specialists. The freer use which he makes of his limbs gives him a more even balance of mass; his body is smaller in proportion to his legs and arms, and he

can employ a very much greater variety of posture. His muscle-leverages are more complicated, and, though he has lost many of the advantages of the quadruped, he has succeeded in countering a good many of the disadvantages incurred by the erect position.

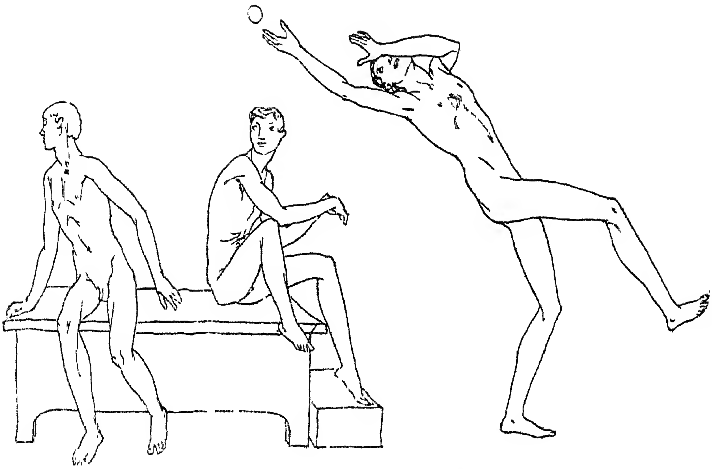


RHYTHMIC CO-ORDINATION

We can trace throughout the structure of man's body his kinship with what we call the lower vertebrates; still more strikingly his similarity to the rest of the family of the mammals to which he belongs. His ancestors were presumably quadrupeds walking on their hind limbs, and all his adaptations to the upright position are of a makeshift kind. Many of our organs are primarily constructed for use in the horizontal position, and although we make do with them in a wonderfully complete fashion, they call for more effort and strain on the part of our nervous and muscular mechanism than they did in their earlier arrangement. In the quadruped, the cage of the ribs hangs supported freely by the spine, swinging forward and back without muscular effort as the lungs expand and contract. In man, the whole bony cage has to be lifted at each inspiration, and it shows, accordingly, a change of shape, a flattening and broadening, which makes this work easier to perform. Several of the greater and more powerful muscles, particularly those of the buttocks, are practically out of action in normal upright walking; the gluteus maximus only coming fully into play when the leg is at an angle with the body, as in the quadruped. This, it has been suggested, accounts for the success of the 'crouching start' in running, for the forward posture of racing bicyclists, and for the fact that elderly and feeble people habitually bend forward when climbing stairs, all positions which bring this muscle into powerful action.

Our muscles seem to have been re-adapted in order to keep the viscera from sagging down into the pelvic basin, which, given the musculature of the quadruped, they would tend to do. All our structures, instead of hanging easily and naturally from the backbone, stand out from it at an angle, greatly increasing the difficulty of the problems resulting from the erect position, the maintenance of which is itself difficult enough.

This question of the sagging viscera is connected by Sir Arthur Keith with the disappearance of the tail in man. Man, he points out, is descended from tailed ancestors, and preserves all the bony structure of this tail in the small bones of the coccyx, which curves inwards

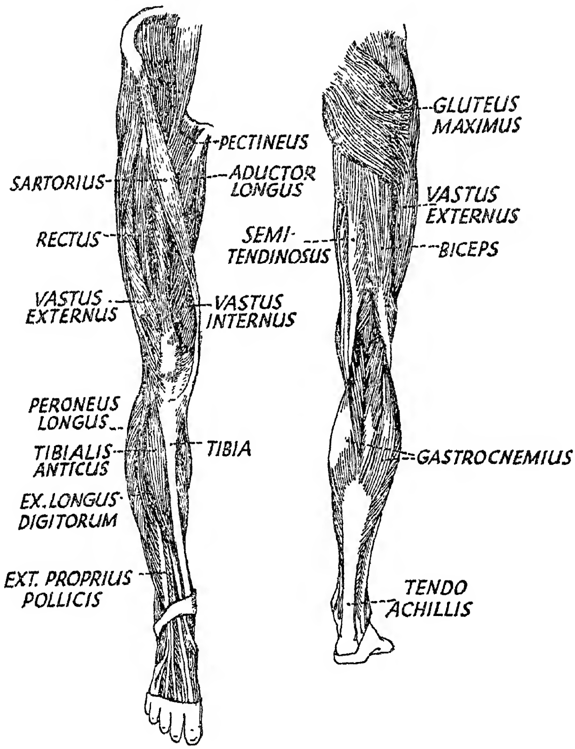


PULL-THROUGH SPIRAL ACTION

sharply at the lower end of the spine. In the anthropoid apes the tail has disappeared as with man. 'When it is remembered,' says Sir Arthur, 'that it is only these higher primates which have attained the erect or upright posture, it will be at once suspected that the disappearance of the tail is a result of change of posture. There can be no doubt that this is the case. When a monkey is held upright its viscera gravitate downwards, and need support from below. The muscles which close the hinder end of the body are the muscles which depress the tail; by depressing the tail the monkey can support or shut in the contents of the abdomen. In man, the greater anthropoids, and in the gibbon, we find the muscles which depress the tail spread out as a muscular hammock across the pelvis to support the viscera. With the evolution of the upright posture the tail became useless as a balancing organ; the centre of gravity of the body became then quite altered. The muscles which depressed the tail were needed for the support of the abdominal organs, and hence the tail became useless in the new economy which was established, and became buried or coccygeal in form.'

The skeleton of the trunk, as well as supporting all the tissues, serves as a protective box for all the important organs. The crab and the lobster, with many other creatures, have carried this plan to its extreme, having all their bony structure on their surface. The human skeleton is admirably fitted for its purpose of strength and lightness, the elastic ribs, for example, being far less cumbrous than any equally strong

arrangement of solid plates. It was, however, even more completely protective when man or his ancestor was quadrupedal. In a state of nature, danger is far more probable from objects and blows falling from above than from anything below. The soft parts of the body—then



Front view Back view

MUSCLES OF THE LEG

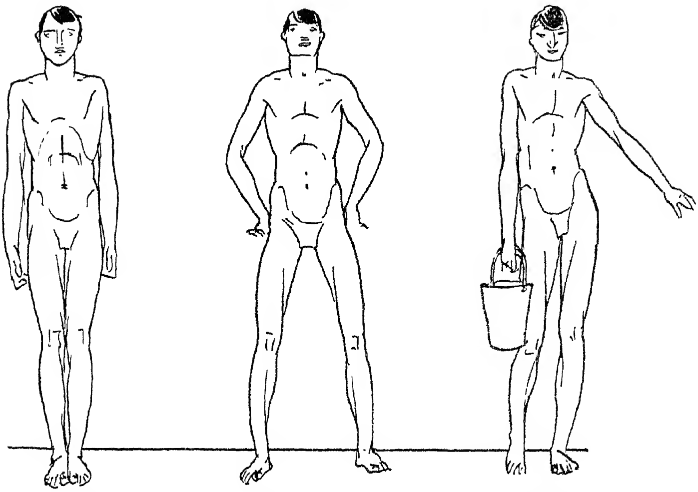
the underparts—were protected by ribs, backbone, sacrum, and shoulder-blades, the only unshielded bit being the short interval between the lowest rib and the sacrum. As we are now modified, the back of the neck would, in walking on all fours, be a vulnerable part; but in the true quadruped the different leverage necessary for the forward carriage of the head brings the spine lower at that point, and covers it with a layer of very strong muscle. At present, direct downward blows are taken on the thick bony cap of the skull; below this, on the strong

shoulder-girdle; below this, again, the iliac crest (where the upper edge of the pelvis thickens) protects, with the flat sacrum, the sides and back of the soft abdomen. Also, as bipeds, we can now use the arm and hands for the warding off of blows and other injuries from the relatively exposed organs in the lower part of the front of the body. The arms and legs, which contain no structures of vital importance to the organism,

EQUAL BALANCE ON A SINGLE POINT

have their bones in their middles, covered and protected by layers of elastic muscle. The spinal cord, the great basic extension of the brain, through which messages are carried to all parts of the body and without which co-ordinated movement is impossible, is completely enclosed in the jointed box of the vertebrae, themselves armoured with bony knobs and covered with thick muscle.

The mass of the trunk, composed of its arrangements of bones in interplay, and its balanced muscles, is used by the limbs as a basis for leverage and muscle-contraction. It will be noticed that when a violent or unusually powerful movement of the limbs is undertaken, the trunk is stiffened and the breath held, with the lungs fully expanded, locking



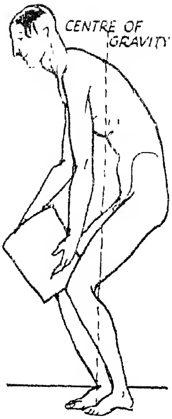
EQUAL BALANCE

EQUAL BALANCE ON TWO POINTS

UNSYMMETRICAL BALANCE

the trunk into one rigid mass. This provides a firm hold for the pull of the contracting muscles of the limbs, and gives great additional force. In carrying out long-continued hard physical work, it is usually possible to shift the strain from one group of muscles to another, at intervals, so as to rest those most fatigued. Pulling with a rope, for example, may be carried out in series by (mainly) the hands, wrists, and forearms, the shoulders and chest, the loin-muscles, and even the muscles of the thighs and legs. Of course, in none of these cases does the one group act alone, but the strain can be deliberately thrown first on one and then on another. So, if we stand for a long period, we shift the weight from foot to foot; bringing different groups into play, contracting the fresher ones, and relaxing the more tired.

The body is normally supported on the under-surface of the feet, consisting of the pads of the heels and the pads of the toes, connected by an elastic arch called the instep. When the weight is put equally on the two feet, with the body upright, a line dropped from the pit of the neck will fall between them. If the weight is put upon one foot alone, this line—representing what is called the centre of gravity—will fall across the middle of the arch of this foot. To attain stability weight must be evenly distributed around this imaginary vertical line. If we watch a child stooping to pick something off the floor, we shall notice that as his body projects forward at one end it projects backward at the other, the feet remaining stationary, so that his weight is still equal



on either side of his centre of gravity. If he merely bent forward from the waist he would fall on his face. When we stretch forward our arm to take some object which is just beyond our normal reach, we put out a hand or a leg behind us to 'keep our balance.' The ballet-dancer does this when she poises on one toe, her arms and body slanted forward, while her other leg points horizontally back. Her whole frame would fit within a triangle standing on its point—the supporting foot.

In the movements of stretching up, bending sideways, picking up weights, throwing and catching, the same law holds. If stability is to be retained, weight must be distributed evenly above the point of support. In the motion of catching a thrown ball, another factor comes into play, similar in its effect on the balance to a push with a stick—that is, the resistance of the hand to the impetus of the ball. The body must be prepared with just sufficient over-balance towards the object to overcome the push. If, while we stand steady on both feet, another person pushes against us with a pole, from the left, we lean slightly towards him and preserve our stability. If the pole breaks or he withdraws it suddenly, we fall towards him. The push is the equivalent of an added weight on the further side of our centre of gravity. So, if we held a weight in the right hand, and could swing it quickly out to arm's length as he withdraws his pole, we should not fall. We should have restored the balance.

We can carry a weight in very many varying ways, and each of these affects our posture differently. If the burden is carried in the hand, the body is thrown to the side away from it; if on the shoulders, the body is bent forward; if in the two arms, the body leans back against the forward pull. The best and most healthy way in which habitually to carry heavy weights is on the head, as do most native and unsophisticated races. When a heavy burden is carried on the head—provided that the muscles of the neck have been accustomed to the strain—most of it is actually supported by the piled-up bones of the spine, these in turn standing on the vertical long bones of the leg. The only thing the muscles are called upon to do is to keep these bones safely piled upon one another. They do very little, if any, of the real carrying of the burden. It is well known that this method of bearing weights gives a graceful carriage to the figure, as all the muscles of the body are in continual delicate counterplay, and develop in rhythm and harmony. Astonishing burdens can be borne on the head in this way, for week after week, by African native porters, men and

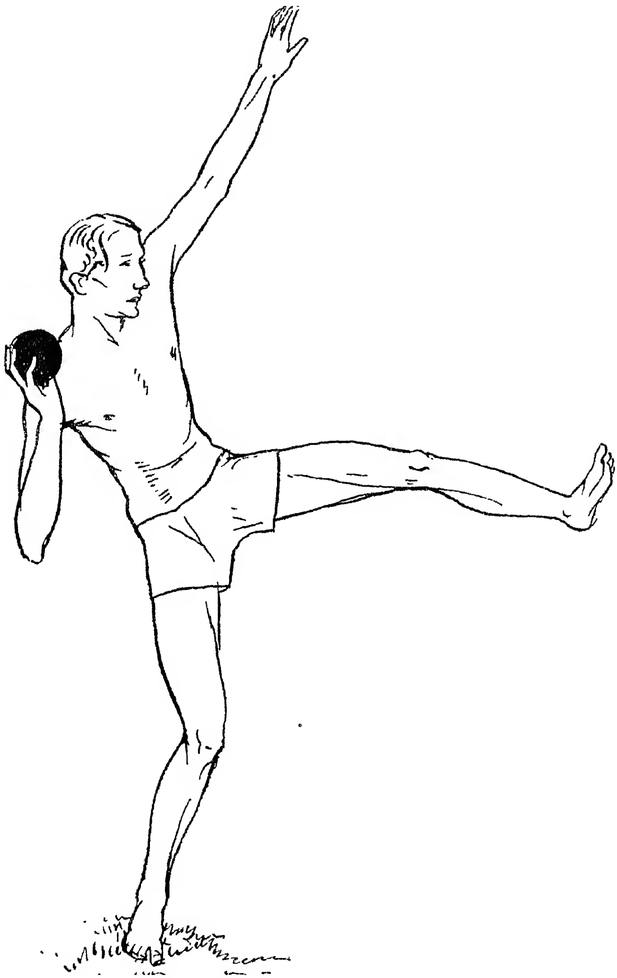
women; the method having the added advantage of leaving both hands free.

When weight is carried in the hands it is far easier to carry a given amount if it is divided into two equal parts, one for each hand. This disturbs only to a small extent the natural balance of the body; but it throws considerable strain on the muscles which secure the arms in their sockets, and those which hold up the 'shoulder girdle.' The backward pull of a heavy knapsack becomes very apparent when we take it off; when, for a minute or two, we feel as if we should fall forward.

So far, we have been considering the body only as standing upright. When we walk, we do so by putting the body out of equilibrium. Each step is, in fact, a frustrated fall. The weight is thrown forward, the body tilts slightly, and we bring the foot from which the weight has been lifted quickly to the front ready to receive it again. If, for any reason, the foot is caught and cannot get to the right place in time, the fall completes itself. When we are first acquiring the accomplishment of walking, the fall very frequently completes itself. The faster we walk, the less stable we are; running is a continuous fall. Only if we wish to stop do we put the supporting foot far enough in advance to establish equilibrium, so that the centre of gravity again falls between the points of support.

In a simple lever, the effect of the force or weight at the end away from the fulcrum or hinge is greatest when the lever is horizontal; in any other position it decreases. Thus, when we hold an object in the hand, the power required to raise it or to keep it at any height increases as the arm is moved away from the body. This can easily be proved by personal experiment. In unusual acts of balancing the two arms are used alternatively as weight adjusters, being raised and lowered in turn, their effect increasing and decreasing in ever-varying degree as the body sways. This is very clearly seen in a person walking a tight-rope or along the top of a fence or wall. The arms are in constant movement, up and down, towards and away from the body, to produce equilibrium. The fencer holds his left arm behind him, raised from the shoulder and the elbow, to help him to preserve his stability when thrusting and lunging. It is essential to him that his body shall be firmly balanced, yet free in its movements; so his left arm comes into play as a counter-weight. The drawing of a man 'putting the shot,' shows how useful is a movable weight on the far side of the centre of gravity. This man, though stability is essential to the heaving of the shot, yet finds his extended leg and foot so necessary a balance-adjuster that he poises precariously on the other only, in order to leave this one—what we might call his 'fluid counter-weight'—free. A few moments of experience in action—even in so familiar an action as walking—with

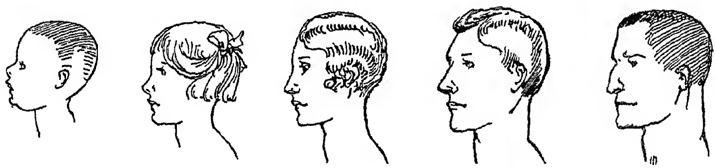
one arm tied to the side, will demonstrate the constant use we make of this leverage in our daily movements.



BALANCE. PUTTING THE SHOT

The human body changes very much in appearance during its first twenty-five years of life, much less during the remaining period. Within this period of growth the average individual increases in height from

twenty inches or so to between five feet and six feet; and in weight from about seven pounds to between eight and twelve stone. The bones and muscles of which our framework is composed do not grow at the same pace all the time, nor do they grow at the same pace all through the frame. The proportions of the baby are quite unlike those of the adult, and until growth is finally ended, between the ages of twenty and twenty-four or -five, these proportions are constantly changing. It is easy to tell the approximate age of a child from a full-length photograph even though no standard of size is given for comparison. The stage of development is shown in the child's proportions. In the usual way growth occurs rapidly during the first two years of life, then slows down until puberty is reached, when it makes another jump, afterwards gradually decreasing till it stops. The development and consequent



EXTERNAL EFFECT OF THE DEVELOPMENT OF THE NECK MUSCLES

thickening of the muscles influences the appearance of the external masses and contours of the body. An interesting example of this change is seen at the back of the neck, where the head is held erect by the great trapezius muscle, in conjunction with the muscles which hold up the spine itself. In the new-born baby this is so weak that the head cannot be held upright, but needs external support. The smallness of the muscle makes the back of the skull appear to project. As the child grows older the muscle strengthens and thickens, and begins to fill up the hollow line from skull to back. In a woman, the hollow at the back of the neck is still marked; in a man much less, till the series ends in the bulging neck of the boxer, whose muscle is super-developed by constant resistance and adaptation to blows on the head and face.

The shape of the figure is still further altered as it grows by the appearance of the sexual characteristics. The fuller breasts and rounder hips of the girl, with the difference in the relative width of hips and shoulders, make the distinction more and more marked. In men, as the muscles develop, the masses are flatter and harder than in women; the bony framework more apparent; and all the lines and curves of the figure are long and flat rather than round as in the girl. Differing physiological function calls for different muscular adaptation, and this again calls for slight adjustments throughout the whole mechanism.

Although it is not possible to alter the physical type peculiar to every

one of us, it is possible to develop that type to its fullest. It is the duty of every one of us to get the utmost out of the physical machine which has been given him; making sure that it works smoothly and with no interference, and that it is handled with the greatest economy of effort, so as to produce its results with ease and pleasure. To this end the human mechanism must be used and exercised. Only by use can it be kept in working order, so that it will perfectly fulfil the demands made on it. In the following chapters some hints will be given as to the methods of deliberate training and upkeep of the muscular structure of the body.

VII—EXERCISE AND HEALTH

Perhaps the outstanding characteristic of the inventions of civilized man is a purposive or incidental saving of muscular effort. It is, of course, doubtful if primitive man sacrificed so large a part of his life to 'earning his living' as does average civilized man in this twentieth century. But the conditions in which his physical efforts were made, and also the strenuousness of such efforts, differed widely from those obtaining to-day. His activities were out-of-door; with the exception of agriculture and a few lesser industries, manual work is now chiefly carried on within four walls. The hygienic consequences of this have been profound. Another distinctive characteristic of contemporary organized industry is the increased monotony and lessened emotionalism involved. Hunting, gardening, fishing, which formed so large a part of the week's work of our early forbears, are now more and more looked upon as recreations for our hours of leisure. Like all other animals, we have minds and bodies which were created, or have evolved, in such ways that, in the 'natural' conditions of uncivilized life, work and health, pleasure and play were inseparably related. Pleasure, indeed, was but the signpost or index finger pointing to that which is desirable and health-giving. Few of us realize how partial, lopsided, and irregular has been his development since thinking and feeling man took a hand in the deliberate alteration of his environment and habits of life. Knowing by experience how pleasant is leisure after work, he has set before himself an ideal of workless leisure. Remembering how comforting is shelter from biting winds, and how generally desirable is cosy protection from cold after the heat of violent exercise, he has idealized and endeavoured to materialize an enclosed life, cut off, not only from the keen winds of winter, but from fresh air and sunshine also. As the artificiality of civilization increases, and established necessity stamps and seals our bondage to mistaken aims, events compel us from time to time either to retrace our steps or, at least, to restore some semblance of those earlier conditions we foolishly sought to escape. It is but comparatively lately that mechanical inventions have reached such a point as to enable many of us, and to compel many more, to live our lives with but the most trifling exercise of our bodies or of our minds. Much of the dreariest and most unpleasant work of the contemporary civilized world involves almost no muscular exercise,

and almost no thought. Practically none of the natural instincts and impulses of man is satisfied or stimulated thereby. Lives so spent are fundamentally unhealthy lives, even though their length, measured in years, may not be shortened. Outdoor work and outdoor play are the natural exercises of man; and the effects of such natural exercise are not just a matter of muscle development, or of breathing pure air, or of chest expansion, or of holding oneself in this or that position; important though, in many ways, all of these are. There is a unity between all parts of the body, and between the body and the mind, which the hygienist cannot disregard. We are apt to talk about our muscles and our nerves and our thoughts as if they had no necessary connection with each other. The intelligence needs exercising, so do the emotions, and so do the muscles. But it is a mistaken notion that would lead us to prescribe for ourselves or for others a sort of scholastic time-table, giving to each of these several educational procedures its appropriate hour—nine to ten, exercise the intellect; ten to eleven, the muscles; and so on. What we want is an intelligent, emotional exercising of the muscles, and a muscular exercising of the intellect and the emotions. A clumsy mover (if not structurally or pathologically handicapped) is apt to be a clumsy and muddled thinker; and, incidentally, to furnish the psychologists with an illustration of emotional stultification. Here we have the reason why games of skill, involving physical and mental activity in really intimate co-ordination, are so valuable. Much of the virtue of a public-school education is dependent on its games. It is, from the hygienic point of view, a pity that handicrafts and games of skill play so relatively small a part in the early education of the majority of our people. There could be no greater condemnation of the customary textbook system of education than the fact that it is so boring to all but a few exceptional girls and boys.

The cultivation of pleasurable hobbies—especially of outdoor hobbies—and of pleasurable handicrafts; participation in outdoor games involving some measure of skill and emotional collaboration, and the reduction of monotony in industry—even at the price of some sacrifice of the material gains of specialization: these things would of themselves restore to civilized man a very great many of the valuable things he has dropped by the wayside in his progress towards his goal. Quite apart from the specific cultural and aesthetic purposes with which the following chapter is more particularly concerned, general bodily, mental, and emotional exercise is essential, not only to the development of muscle and the attainment of bodily and mental agility, but also to the harmonious working of the whole intricate hierarchy of systems that make up the living creature, man.

Methods of Physical Education: Faults: Neglect of the Gymnasium

The education of civilized children must include instruction in physical exercise. For the most part, what may be called the British System of Physical Education is based upon the playing of games. Certain of these games are carried on by most boys as they reach adolescence, and proceed to young manhood, the national games of cricket and football—rugby and association—being the best known. Athletics—that is to say, competitive running, jumping, weight-putting, and other field sports—are hardly seriously undertaken by boys, the severe training required being impossible in schools, and, in any case, harmful to adolescents. Gymnastics has a place in all school curricula, but whereas in Northern European countries this forms the main part of the physical training of the young, in this country its influence upon the development of the growing man is becoming almost negligible. Although it is not desirable that the playing of our great national games should be discouraged in any way, it is certain that there are many cogent reasons for the reinstatement of the gymnasium as the fundamental factor in physical education.

The Swedish and German systems are the two main types of physical training by gymnastics. The employment of apparatus—consisting of the horizontal bar, the parallel bars, the vaulting horse with spring-board, rings, rope, trapeze—in the German system, while the Swedish system merely uses means of fixing parts of the body to aid in the performance of static exercises, indicates the difference between the methods. Both systems use mass drill of various kinds, leading up to advanced ground gymnastics, pyramid-building, and other intricate evolutions, the Swedish being carried out to word of command, and the German to example (imitation), time, or music.

THE CASE FOR GYMNASTICS.

We British do not like drill. It appears that most continental nations love it—or is it that the dominant type in each country loves drilling the weaker members of the community? But boys—and grown men—have respect for those who can perform feats of agility. Most of us have not had the chance to learn these fascinating exercises on the bars, rings, and rope, because, forsooth, they have been judged too dangerous by a majority of those responsible for our education. In the time at the disposal of the drill sergeant or gym instructor, the interesting part of ground gymnastics cannot be reached. The boys have little interest in 'stale' drill. The exercises have no value unless done with spirit, so that most of the time spent at drill is wasted. Young people could be stimulated to perform their drill with zest by the promise of instruction in real gymnastics, and the competitive

spirit would be stimulated by the reintroduction of Gym 'Eights,' Inter-school Contests, and the earning of Proficiency Badges. Some result would then be obtained by the drill exercises, and an improvement in deportment and physique realized. Many boys who waste time in the lower teams of cricket and football would benefit more from time spent in the gymnasium: if they were to show more talent for gymnastics than for games an inferiority complex might well be removed. Many boys who, through lack of weight or susceptibility to cold, are really unfit to play rugby football, might shine at gymnastics. It has been proved that with good instructors there is a trivial percentage of accidents in the gymnasium, and even if it is considered that there is some slight physical risk is not courage one of the finest moral qualities? The ability to perform instinctively some simple feat of agility will often save one from serious accident, even from death. If your 'head' for climbing has not been proved, how would you like to be cut off by the tide, and have to climb a cliff? Chased by a bull, can you vault a high gate or fence? There is no time to climb it! In motor accidents, during storms at sea, or in an unexpected fall, the trained gymnast will always 'come off' as lightly as possible.

It may have been mere coincidence that the final decline of gymnastics at our great Public Schools should have come simultaneously with the formation of the Junior Officers' Training Corps. It may be imagined, however, that many instructors might have been tempted to divert some of the hours allotted to physical drill to military drill, or rifle-cleaning. Many universities have no facilities for the practice of gymnastics, and often one finds that the mainstay of gymnastics nowadays is the working-man's club or institute.

The selection of drill exercises should be carefully made to avoid the chief faults of Swedish drill. Constrained, stiff positions and jerky, unnatural movements during drill must be varied by swinging, rhythmic exercises, which may be found described in French variations on the system. The attention and the body tire from tense waiting for commands. Indian clubs, swinging and dance-like exercises, bring graceful variation into drill. If the attention is allowed to tire slackness creeps in.

Points in Athletics: Training: The Heart and Circulation

The great athlete is born, but even he has also to be discovered and 'made.' The process of training must be gradual, but in some cases it may be safe to go faster than usual, this depending upon demonstrated capacity for standing more than the normal strain. Boys show an extraordinary power of endurance if their work is varied and they have frequent rests, but it is seldom safe to subject them to much acute

strain or continued effort in one direction. Such strain and effort call for great care in training, because of the danger of overworking the heart: every precaution must be taken to avoid this, particularly at the beginning of the season's training. In practice it is not safe to put the athlete to the utmost tests until close upon his first serious engagement. One mistake may injure the heart to such an extent that it may never recover. The aim in training for athletics should be to increase the output of energy so gradually that the heart becomes strengthened as more is demanded of it. If a breakdown occurs during training the athlete's heart remains dilated for days or weeks, whereas it should return to normal very shortly after the effort has ceased. This dilatation is caused by the increase in blood-pressure which follows the stimulus given to the blood-vessels by the strong action of the muscles, controlled through the nerves by the brain. The fibres of the heart-muscle respond to graduated increase of work put upon them by becoming both stronger and more elastic, and thus the walls of the heart become thicker. During violent exercise, as the poisons of exhaustion accumulate, the heart must be ready to put in its effort to supply more and more blood to the lungs for the elimination of carbonic acid, and the supplying of the body with clean blood. When the muscles are taut and healthy the blood-pressure will be found to be slightly raised; if the athlete becomes 'stale' his blood-pressure is lower than normal, and remains so until he recovers his 'form.' At the peak of a man's training he should be able to recover from the exhaustion of the supposed hardest distance—the quarter-mile—in about one hour and fifteen minutes, but much depends on circumstances. The finish of every race from the two hundred and twenty yards to the twenty-five miles may leave each winner equally 'exhausted,' according to measurement by scientific tests. But the latter distance could hardly be faced again on the same afternoon, whereas a short-distance runner might have to run two 'quarters' within an hour of each other, and might win them both.

CARE IN TRAINING.

It is held by some trainers that during preparation for the mile race, three-quarters of a mile should not be exceeded as a practice distance. Then the runner will have all his resources and reserves of strength to gamble with during the last quarter-mile. This method appears rather dangerous in that tactics must be varied to suit the case: the young runner might easily be 'bluffed' out of a win by a clever opponent dealing too softly with him during the bulk of the race: by all means spare the young runner in his preparation, but make sure that he knows what he can do before his first great test: after that is over the safety of this plan of training can be assured. In any case, the opinion that the distance to be trained over should be two hundred and twenty

yards short of the mile is probably to be accepted, but the runner must be coached to undertake 'spurts' at any time he is called upon to do so.

Long-distance running demands the strongest heart in the first place, yet it has been found that with careful and constant training—or, to put it more correctly, with both careful training and constant care—some of its exponents have been able to continue to run in championships longer than any other type of runner except the short-distance sprinter. Only young men can go 'all out' for distances over one hundred and twenty yards. Nothing can be 'eased' in races up to the quarter-mile distance, whereas the experienced 'distance' man learns to conserve his strength in many ways, particularly if he has perfected himself in muscle co-ordination by means of physical culture.

'ATHLETE'S HEART.'

Medical control of training by doctors skilled in the knowledge of the requirements demanded by various forms of athletics should be insisted upon by those in authority in the universities and athletic associations. Where are those sad cases of men who have had world-famous names in athletic circles dying suddenly or being chronic invalids on the brink of dissolution? They are seldom heard of nowadays. 'Athlete's heart' was a genuine bugbear, when many young men took pride in their ability to stand the exhaustion of a cross-country run, a weekly game of rugby football, even a boat-race, without undergoing thorough preparation, or before correct training methods were understood. Much is owed to those who have devoted so much of their time to research work upon this important subject; thanks to them, many lives have been saved. Associated conditions are against men spending too many years at competitive sports. Occasional 'turning out' is to be deprecated. The repeated abuse of a heart by threatened or real exhaustion caused by its owner rowing or running himself 'out' without the full training 'as laid down,' can only end in evil: it will be luck if such a course ends with nothing worse than a permanent 'weak heart.' The temptation to 'come back' is a great one. It comes to the very strong man, or the very famous athlete, who may have been head and shoulders above his contemporaries only a short while before, and who is probably contemptuous of the present opposition: the professional is tempted by a large 'purse'—the amateur by 'You are the only man who can possibly do it!' DO NOT DO IT. You may win—but it will cost you too much in the end. One season missed by the sprinter, the oarsman, the rugby player, or the boxer, if he be over twenty-five, may make it dangerous to resume, without a complete and searching training. Two years untrained, and the 'old form' cannot possibly be regained. Any exceptions to this rule

have been men who have lived the simplest of lives, and have been kept fit by means of constant hard physical work in the open air.

The age of twenty-five is the average which should not be exceeded by the amateur of the most strenuous sports. With great care he and the professional athlete may continue until thirty. For some years after this the boxer may possibly carry on, as his sport is in a category of its own owing to the compulsory three-minute rounds, and the peculiar combination of strength, skill, and experience required. Association football may safely be played for ten years longer than rugby, though speed of foot is certain to diminish gradually. Possibly, with professional training, the rugby player could keep his place for a year or two longer, but it is doubtful if his speed would serve for the positions demanding the powers of a sprinter, and he would be increasingly liable to injury. Hockey is often taken up by men who are just not able to continue their rugby career, but this game cannot be considered to be outside the 'strenuous' category. But many are the outlets for everyman's energy, apart from the strenuous games of youth. Cricket of by no means inferior quality is played by many middle-aged men: fifty—even sixty—years do not necessarily lay the active, healthy cricket enthusiast 'on the shelf'; although, of course, young men are needed for the continued strain—if not for the brilliant speed—of test matches with Australia. Bowling powers decline with years, but apart from certain positions in the field there is still a place in a county team for the potential 'centurion' of fifty! And there are other teams. Is golf 'an old man's game'? Yes. And it is also a young man's game. But surely we would rather our son's Saturday afternoons were spent slinging the oval ball from the base of a sweating 'scrum' than lying on his stomach studying putts. Tennis requires an athlete, and one who is in no mean training, to win at Wimbledon; but the skill of middle age, in any class but the highest, can lower youth's colours—and without danger. Repetition is invited by reference to swimming, climbing, dancing, riding, and many other common physical diversions too numerous to detail: practically all may be enjoyed until everyman takes the arm of his athletic grandson as he tells of his pristine prowess sixty years ago; but the desperate finish, the easy ascent of the Cairngorm as an afternoon stroll, or the clapping for the twentieth set of the foursome reel—these must be left to youth. Another factor in the consummation of our healthy, human desire to 'keep up our interest in games' is the theme of this chapter: 'KEEP FIT FOR YOUR AGE. HOW? BY KEEPING UP YOUR EXERCISES.'

Causes of Avoidable Deformities

Bones are not such rigid structures as is commonly supposed. Cartilage persists in certain parts of the body throughout life. Liga-

By courtesy of the Trustees of the British Museum

SICKROOM OF THE FOURTEENTH CENTURY

From a Bible History

ments can be stretched. Tendons are slightly elastic, and muscles may become permanently shortened. Movement at joints is impeded by the results of bad treatment of strains and sprains. The adult, therefore, needs to continue to be careful not to allow bad habits of posture to develop, and must guard against unconscious peculiarities of gait and the over-development of any group of muscles in relation to others. Children depend on the care and instruction of their parents and teachers for protection against the permanent results of incorrect posture and habits. 'Tics' develop with miraculous speed in imitative and subnormal children. 'Blinking,' jerking of the head, and palsy-like shaking of the limbs are habits far too commonly met with.

Defects of vision, which can be partially corrected by narrowing the eyes, lead to peering and poking the head forward. Astigmatism, often so slight as to be apparently negligible, is a frequent cause of the head being held tilted: this corrects the apparent sloping of the horizontal which is caused by the usual type of astigmatism, and may become so much of a habit that when an attempt is made to correct the ocular error with eyeglasses great difficulty is experienced by the individual concerned in readjusting his head-position. The shoulders follow the head, and only the tailor may discover that one is very slightly higher than the other.

Even very slight deafness in one ear may cause that extremely ugly habit of turning the head as if to direct the sounder ear towards the speaker, and it is amazingly difficult to break a child of this, although the original cause may have disappeared. It saves endless trouble if the causes of these habit-positions are recognized in good time as, apart from increasing difficulty in stopping the faulty movements, curvature of the spine is not long in following in their train.

Spinal curvature is also caused by faulty standing positions being adopted to ease the tired muscles of the back, and for this reason children should not be kept standing too long. The graceful position of rest while standing has nothing wrong with it provided that it is frequently reversed, and a good 'stretch' performed occasionally. The weight is borne almost completely by one leg and hip, the other leg being placed lightly on the ground outward and forward; the shoulder of the same side as the raised hip falls, and the other shoulder is raised; the spine taking the form of an even 'C' curve away from the supporting side. The ungraceful standing position with feet slightly apart, chest hollow, shoulders rounded, and stomach protruding, should never be adopted for more than a moment. Sitting with the hips tilted also produces this curve of the spine, and the vicious circle of tired spinal muscles, faulty positions of attempted rest, increasing curvature, and chronically tired and aching muscles is easily set going by many other 'bad-habit' positions. In the adult, spinal curvature has usually

persisted from childhood—or is caused by disease, and therefore is outside the scope of this section.

The correct standing posture, at 'attention,' for the child as for the adult, is with the head raised easily, with the chin drawn in; the chest raised, but not stuck out, the stomach and abdomen drawn in and flat in surface. The buttocks should not be protruded exaggeratedly, so as to hollow the back, and overtilt the pelvis, but should slope gently out from the loins. The knees should be straight, but not strained, and the inner line of the feet should point straight forward. Roughly speaking, if looked at in profile, a line dropped from the tip of the ear should pass the middle of the point of the shoulder; the middle of the hip-bone; the knees, and the middle of the great arch of the foot. When sitting at work, which is the time in which the greater proportion of childish postural faults are acquired, the upper part of the body should be carried in a straight line, perhaps tilted a little forward, if necessary, but never curved forward; the head, neck, and trunk being in one line. The buttocks should be firmly planted on the middle of the chair seat, with the back touching the back of the chair; not slouched forward to the front edge of the seat; and the feet should rest squarely but comfortably on the floor. If the chair is too high to permit this, a footstool or a small box should be put under the feet. The body should be kept square with the chair-back and the desk or table, not twisted. The seat of the chair should slope down very slightly from front to back, and it should be deep enough to come well under the knees.

During study hours it is good to have a break every hour or so, or whenever the subject is changed, and if the child cannot go out of doors for a quarter of an hour—which is the ideal—he should do some simple exercises to supple up the limbs and body and rest the muscles which have been taking the strain, before taking on his new task. These are especially useful in the winter-time, when the circulation must be kept going briskly; whilst, at the same time, 'going out' entails a certain amount of changing of the clothing, which may too thoroughly disturb the studious mood. Children can very easily be led to take a real interest in their own physical development, and so to co-operate intelligently in the building-up of a good and useful structural framework for their bodies.

Real deformity seldom afflicts the adult as a result of mere postural errors, unless severe stresses or weights are allowed to distort or press upon a yielding part of the body. Persistent adoption of really bad posture may, however, have permanently ill effects. In the adult the first step in dealing with such a case is the securing of the active co-operation of the subject. It is easy to rouse a hostility in his mind which may set up an opposition—often unknown to himself—to the treatment. He may genuinely believe himself to be unable to hold his body, or to

perform some movement, otherwise than as he does. This can usually be got over by persuading him to perform a different movement or series of movements, which, when carried out, will entail the making of the one desired. When this has happened once or twice, but not earlier, the subject's attention may be drawn to it.

During the process of correction of an habitual malposition it is, of course, most important to deal with the original cause; to remove or alter any circumstance which may have given rise to it, or be associated with it in the subject's mind; and then to re-educate the muscles so that their natural and unconscious response to a physical stimulus may be a correct instead of a faulty one. All remedial exercises should be purposive—that is, they should be consciously directed towards the replacing of the bad muscular habit by a good one. It is sometimes helpful actually to ask the patient deliberately to assume his faulty attitude—slouch, stoop, shoulder-twist, or bad foot-position; this often has an excellent effect in detaching it, so to speak, from him, so that he can study it dispassionately and recognize its difference from the ideal. Again, anything which will call his attention to a relapse into the bad habit is useful. Tightness across the shoulders from a stoop; pressure round the stomach and abdomen when sitting badly: things like these may be very useful in keeping one from falling back into error. If a bad habit can be made conscious instead of unconscious, it has gone a long way toward cure. But throughout all treatment, a real desire for improvement is the essential basis. The subject should be made to realize, through precept and example, what a difference he can make in himself and his appearance—how much better it is to hold oneself smartly and walk with a soldierly bearing, than to shamble along with stooping shoulders, hands in pockets, and flat feet. We all know the hunched shoulder of the student who constantly tucks his books into his armpit; the 'De Quincey' walk, nose leading and arms stationary at the sides; the 'single milk-pail' walk, one arm ungracefully swinging forward and outward, the other acting as a stiff pivot; the 'sheeny' walk, feet at 'quarter-to-two,' trousers flapping; the 'pouter-pigeon,' caused by corns or sore feet; and other gaits too numerous to catalogue. Another horror: why do so many women cultivate a walk characteristic of that of a screen 'vamp' descending upon her prey? And its counterpart, the clumsy lurch aped by the admirers of certain 'husky guys' of the films. No practising physical culturist, taught to know what his limbs are doing, could possibly make such an exhibition of himself as is seen countless times in a short walk through our streets. All careless habits, such as these, indicate lack of co-ordination, and lead to minor disabilities which could have been avoided.

CORRECT WAY OF WALKING.

In correct walking the toes should point almost straight forward, and the weight of the body be taken on the outside of the heel and foot, and the transverse arch formed at the base of the toes. There is no need to 'spring' obviously when rising on the forepart of the foot, but the step ought to show by its smartness that some muscular power is being used. The great toe is bent considerably as the other foot is placed on the ground, therefore any condition interfering with its free movement leads to a faulty action of the foot. A well-known Edinburgh surgeon, Professor Thomson, taught that the faculty of being able to raise the great toe perpendicularly to the ground is the most important function of the foot which we must continue to preserve: perform this action while your weight is on one foot, and you will see how the arch of the foot is emphasized, and feel the additional strength conferred. The large joint at the base of the great toe is exposed to injury from 'the hammer of the hard high road,' to deformity from deflection of the whole toe by narrow shoes with the wrong shape of inner edge—which ought to be straight—and to inflammation often associated with bunions and corns. Any of these painful things tempt the sufferer to 'take off' over the inside of the foot without raising it on the toes, and to do this it is necessary to walk with the foot pointing outward. It is then seen that the inside of the heel of the shoe is wearing, and, as it wears, the foot is allowed to assume an even worse position. At the same time the great Achilles tendon, which should stand out straight down the back of the ankle, begins to sag in a weak curve outward: the calf-muscles are working at a disadvantage, and become easily tired. If the owner of this foot, which is crying out for only a little attention, has to stand long, or carry heavy weights, he or she will probably attempt to use the bones of the foot and leg as props without the needful secondary support of the muscles, which have become lax and lost their tone. The great plantar ligaments in the sole of the foot become stretched, the keystone ankle bones are pushed down, and Nature's architecture collapses. Usually the condition, when it has just become fully developed, causes extreme discomfort, and medical or other advice is sought, but it is also one of the really amazing examples of a real deformity which can develop through simple carelessness without any pain whatsoever, and entirely without its being noticed by the person involved. Boys who are to become ploughmen are prone to flat-foot from the walk which they adopt as they follow their plough, placing their feet on each side of the furrow—their attention being on the horses and on keeping a straight course. As many of these lads grow to be fine big men, and often wish to enter the police force, this disability is an important one to guard against. The classical flat-footed policeman is called to our minds at once, his disability being caused by much standing in unwieldy boots:

'flatty' is a common nickname for one of this body of men. As the hard-worked veins of the leg with their poor valvular equipment depend largely for support on the tone of muscles, varicose veins are another likely disability to look for if flat feet have been noted.

Good exercises for the flat-footed are those which aim at strengthening the arch of the foot. The simplest of these consists in standing with the toes together and the feet parallel; then raising the body on tiptoe. Whilst rising, separate the heels as widely as possible, throwing the weight on the outer toes. Lower slowly to the original position. In the next exercise sit on a chair, with the feet pointing straight forward and parallel. Try to place the soles together by lifting the inner edges of the feet. In the next, while standing with the toes close together, rise slowly to tiptoe, and as slowly lower again. Then walk on tiptoe, with the weight on the outer edge of the toes. The last exercise is performed sitting; the bare feet are placed on a piece of cloth laid flat on the floor, and the cloth drawn into rolls by repeated curling of the toes; the big toe should be raised as high as possible at the beginning of each movement.

Remember how easily flat-foot develops: it wastes no time to walk on one's toes occasionally and exercise the feet and calf muscles. Remember what a nuisance lumbago is: 'straighten up' now and then, forcing back the shoulders—hollowing the vulnerable spot. You are addicted to 'pulling' when you have the chance of a game of golf: probably your right arm muscles are over exercised and developed—'change hands' frequently. If you are always out of breath after running up a short stair, try going up a little more slowly, but make sure that both legs are sharing the work equally, and try to put a certain amount of resistance against muscular action into the climb, breathing deeply several times as you come to the steps. The results of these experiments will probably please you; there are many more. Remember that 'being out of breath' often follows an effort because enough oxygen supply has not been laid in previously by taking a few deep breaths. We do not use, or exercise, our lungs nearly enough. It has been proved that pure oxygen has little effect upon the speed of recovery from exhaustion, but that an athlete can run twice as far without taking a breath if he has breathed pure oxygen for a few minutes.

Keep Fit All the Time

A man may, quite without fault on his part, be so situated that he is kept occupied during the whole day and nearly all the year round; time for recreation only being available during a short annual holiday. He may be a strong man, and impatient. He may be hustling up and down stairs, hurrying from one appointment to another, and apparently

keeping his muscular system fit by constant use. But this very active, alert, even athletic, man one day goes away for his holiday, straightway packs a tremendous amount of physical exercise into each hectic hour, and is overwhelmed with surprise when he has a 'heart attack' within a few days. He may not recognize this sudden feeling of tightness in the chest and struggle for breath, as a 'heart attack,' if he feels better in a short time; and he sets his teeth in the determination to continue his strenuous efforts to get as 'fit' as possible in the least possible time. The next attack may be a catastrophe, a 'shock' from cerebral haemorrhage or a fatal attack of angina pectoris. This series of events is merely an exaggeration of what happened quite normally and healthily when the same man entered upon 'training' when he was a youth. The important difference lies in the fact that his 'blood-pressure' was high before he began this too strenuous holiday. The further raising of the blood-pressure necessary to maintain an increased output of energy has resulted in overstrain of a heart already 'tired' by the year's work. This unfortunate man should have begun with a rest, and have taken things easily: then more exercise could have been allowed, but only gradually increasing day by day. The effects of the 'blood-pressure' had not been noticed—except the tired feeling—and the danger of increased strain had not been realized. This type of tragedy has become so common that one can hardly open a newspaper without reading of a similar case, or finding an article by a medical man upon the subject. If this busy man had kept his whole muscular system fit by means of daily exercises so that it would have kept going without so much effort, he might in the first place never have become so tired before his holiday, and secondly, not have collapsed when he attempted to perform his old feats without preparation. A common answer to the doctor, when he gives advice to both men and women to take, or give themselves, walking exercise of a certain distance every day in the open air, is: 'Don't I get enough exercise doing my housework? (or whatever the daily occupation may be).' A remarkable fact emerges from this question, and its answer—which latter is nearly always, 'No; not of the right sort!' Unless your mind is upon your work the results, so far as keeping 'in training' goes, are of little value. This is proved by everyday experience, for every woman who has a busy time with a home and family should be able to walk at least ten miles at three miles per hour without being exhausted. How many can? Our daily tasks are done mechanically. Unconsciously, and perfectly rightly, our bodies carry them out with the least possible effort. If, at any moment, one stopped to criticize one's position or attitude from an aesthetic or from a 'physical' viewpoint, one would probably mutter: 'Heavens! I must pull myself together!' And this is precisely what one should do, whereby many funny little habits would be noticed and checked.

VIII—CONCERNING DRESS

MAN is not the only animal that clothes itself artificially. The humble caddis worm constructs for itself a costume as elaborate in its way as any to be seen at a royal reception. But the dress of the caddis worm and of other tailoring animals is practically constant from generation to generation. No variations are introduced to meet new circumstances or new emotional demands. Man is the great experimenting animal; he is always trying something fresh and finding out whether it works—whether it satisfies him and his needs. There is good reason for assuming that man first appeared on the earth in a sub-tropical region; possibly not far from the supposed site of the Garden of Eden. At an early stage it is likely that he discovered means for protecting himself against the colder seasons even of that climate; though legend, which is often an embodiment of truth, has it that his earliest sartorial effort was rooted in a self-conscious perversion of modesty.

Whatever may be the early history of human dress, it is mainly through this artificiality that man has been enabled to wander over the whole area of the globe, and to settle down and thrive in regions far removed in space and in conditions from his original home. No other animal has so wide a geographical range. By means of clothing the human species has withstood conditions that would otherwise have proved lethal. Like every other experiment, and like every other invention of man, the adoption of dress has brought certain unanticipated troubles in its train. Fortunately, what man's ingenuity has devised it can usually amend. If he will but make full use of his knowledge and intelligence, he can derive from dress all the benefits which he set out to obtain; and, at the same time, avoid the many hygienic, aesthetic, and even moral evils that clothing has introduced into his life. Here we are mainly concerned with the hygienic problems. In order usefully to consider these, it is necessary briefly to analyse the ways in which clothes assist man in his search for health and liberty, and the physiological dangers attendant on this interference with the provisions that Nature has made.

Regarded mechanically, man can be looked upon as a conglomerate of machines, each one of which, like other machines, is constantly liberating or creating heat. It is the activity of the individual cells of the body, and the chemical processes in which they play a part, to which we owe the warmth of our blood and of our bodies. Had we no means

of cooling ourselves, and were we not possessed of elaborate machinery for this, we should become hotter and hotter with every minute of our lives. Our blood would boil, and our works would seize.

Heat Regulation of the Body

The cooling process is effected principally by means of the skin. Through it, as through all other parts of the body, blood is constantly flowing; and, according to the extent of its exposure and to the temperature of the air, the blood-heat is lowered. Our own sensations are an unreliable guide to the actual temperature of our blood. A feeling of cold is experienced when little blood is circulating through the skin; a feeling of warmth when the surface-flow is more generous. By no effort of will can we alter the size of our blood-vessels, or the relative flow of blood through any particular organ or tissue. This is regulated with great nicety by certain controlling mechanisms that are part of our inheritance. When the surrounding atmosphere is relatively warm, as also when, through active exercise, much heat is being produced within our bodies, the blood-vessels of the skin dilate so as to expose an increased amount of blood to the cooling influence of the air. When, on the contrary, the air itself is cold and we are at rest, these vessels contract, thus forcing the blood to flow in greater volume to the internal parts. There is, moreover, a supplemental provision for balancing excessive production of heat. Distributed over most of the surface of the body are small specialized collections of cells known as sweat glands, which have the power of abstracting water from the blood, and expelling it on to the surface of the skin, where it evaporates, and thus still further helps to cool the body. These are elementary facts which must be known to all of us from personal experience, though probably few of us have given much thought to them.

Hygienic Aspects of Dress

We are now in a position to consider some of the more important of the hygienic aspects of dress. Leaving aside all question of decency, which, after all, is mainly a matter of convention, the prime utilitarian purpose of clothing is to limit the loss of heat from the skin when the surrounding air is so cold as unduly to tax the vaso-motor controlling apparatus within us. Our clothes, therefore, should be bad conductors of heat—that is to say, they should allow heat to travel through them slowly. Experiment has shown that the texture of our garments is, in this matter of heat conductivity, more important than the nature of the fibre of which they are composed. Whether we are

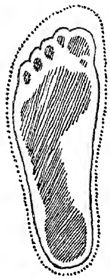
anxious to prevent our animal warmth from escaping too rapidly on a cold day, or to hinder the heat of the sun from oppressing us on a very hot day, it is proved that a moderately open woven fabric is far more effective than a closely woven one. Flannel owes its reputation as a clothing material to the fact that it is so structured as to hold in its interstices minute particles of stationary air. Woollen blankets are bad conductors of heat for the same reason. But cotton wool is as effective a non-conductor as is animal wool, and cellular fabrics of cotton or of silk may be just as satisfactory clothing materials as are flannel or woollen ones.

The emanations from the skin are, however, to some extent excretory and, therefore, should have freedom to escape. This applies particularly to the secretions of the sweat glands. Any fabric, therefore, which is worn next the body should be readily absorbent as well as reasonably porous; otherwise, we are for all practical purposes draping ourselves in a rather unpleasant poultice. Moreover, our aim should be merely to supplement the regulative capacity of the skin, not to replace it; for all our faculties, physical and mental, soon lose their potency if they are disused. It is well known that people who habitually coddle and overdress themselves, fearing the slightest contact with the elements, and avoiding exposure to temperatures ever so slightly above or below the normal, are particularly prone to colds and to more serious illnesses, when they happen to encounter inclement weather conditions without their usual protection. They have, to use the common phrase, lost their power of reaction or adjustment.

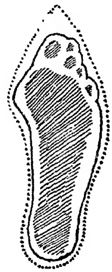
Our garments should not only be effective non-conductors of heat and ready transmitters of moisture, but they should also be as light in weight as is compatible with the circumstances of the season. We have been accustomed to cover ourselves with far too many superimposed layers. If the materials are wisely chosen two thicknesses of appropriate weight and substance should be adequate at most times and in most conditions that obtain in this country. Rain and biting wind may call for a suitable supplemental external covering, as also may enforced sedentariness in times of extreme cold. Then, again, all clothing should be reasonably loose, interfering as little as possible with the movements of the limbs or of the muscles of the abdomen, back, and chest. During two or three months of the British summer scarcely any clothing is called for if hygiene is the prime consideration; some protection from the sun's rays may be necessary during the middle of the day, since excess of sunlight can be nearly as harmful as its lack. Probably the best and most sensible hat for summer use both for men and for women is the Panama-grass hat; this is light and comfortable, and affords effective shade. It is difficult to understand why it is not more generally worn.

Boots and Shoes

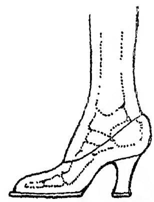
The question of boots is a very important one from the point of view of health, as well as from that of comfort. Male fashions have in recent



IMPRESS OF NORMAL FOOT



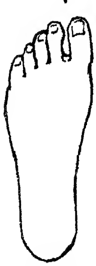
IMPRESS OF DISTORTED FOOT

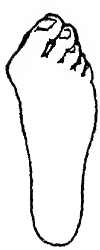


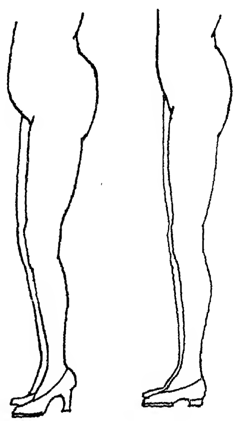
DISTURBANCE OF ARCH OF FOOT CAUSED BY HIGH HEELS

UNDISTORTED FOOT

FOOT DISTORTED BY ILL FITTING SHOE







EFFECT OF HIGH HEELS IN THROWING THE BODY OUT OF BALANCE

years become more sensible; but women's footwear remains, all too often, at the top of absurdity and discomfort. There is really nothing to be said for the high heel or the narrow toe; both are ugly and deforming. Not a small proportion of the chronic ills from which women,

not afflicted with any particular disease, suffer, may be traced to the ridiculous shoes which they have allowed custom to impose on them. The foot is very subtly structured to bear the weight of the body in movement and at rest. To allow for the varying line of stress, the bones which compose its arches are wonderfully arranged and jointed together. Narrow and ill-shaped shoes nullify the whole of this ingenuity. Commonly these living and mobile structures are treated as though they were mere dead plaster bases capable of being moulded according to the whims of the designers of fashion plates.

A sensible boot or shoe should be so shaped as to have a practically straight inner sole line from heel to the tip of the big toe. The front of the shoe should be as wide as the toes when spread at their widest. The heel should not be more than about an inch in height, and should be as broad as the human heel that is to rest on it. The length should be such as to allow for the fullest extension of the toes when the body, bearing a substantial weight in addition, such as a well-filled suit-case, is supported by the feet. In the case of shoes as distinct from boots, the side should be cut low enough to allow free action of the ankle. The leather, or other material, of which the boot or shoe is made should be reasonably pliant. The fitting round the arch, instep, and back of the heel should be fairly snug. In another section of this book are described certain foot deformities due to the wearing of ill-fitting and ill-constructed shoes; and some advice is given as to the best way of remedying these often serious ills.

Nudism

Perhaps a word should be said about a movement that has recently attained a good deal of notoriety, the nudity movement. It is probably difficult for most people to contemplate this development with an impartial mind. It is doubtful if, in this country, except possibly for a few weeks in the year, nudity is hygienically practicable. On moral and aesthetic grounds this is probably regrettable. The possibility of covering up our misshapenness with clothing is apt to lead to aesthetic and physical slovenliness, and to lack of wholesome pride; whilst one can only regret that man, uniquely among the animals, has developed a sense of shame relative to the body with which he has been endowed. The line between prudery and pruriency is a very tenuous one. In the long run we shall find that the dress which is in the widest sense most hygienically fitting is also the most aesthetically and morally satisfying.

IX—THE HOUSE

Man is the supreme home-maker. Probably in no other species does one find the home such a definite centre of the activities of life, and the family such a definite unit. Perhaps this is because man tends to permanent mating, his family is relatively small, and his offspring take many years to reach maturity. Perhaps because, his natural protections, apart from his wits, being few, he is forced to give more time and thought to the elaboration of his dwelling, which therefore means more to him.

One does, however, find the home-making instinct in many animals. The need to have a regular resting place, which shall form a protection from enemies and from the elements, is felt by many species, as it was by early man. Some animals show great ingenuity in choosing and adapting suitable homes. Many have the instinct to return to the familiar spot, to have a permanent resting place; although with some the home is simply a temporary dwelling for the short time required to nurse the offspring through their brief youth. In many birds' nests we find superb craftsmanship and much beauty, as well as safety and comfort. In the beehive and the ant-hill are manifest great communal activity in construction, and specialization in use of different parts of the home. But man, with his adaptability and his mechanical ingenuity, can surpass all these. As civilization advances his home becomes more complex and more suited to local circumstances.

Nowadays our occupations are specialized, and few of us build our own homes. But we plan them or choose them, and the interest remains. The services of a variety of expert workers greatly increase our scope in home-making, and civilization is ever adding to our choice of material and to our knowledge of utilizable means. Through our gregarious instincts and the needs of a specialized life most of us tend to live in communities, but the home and the family remain essential units.

Although elaboration may make for increase of comfort, this is probably not the key to man's success as a home-maker. Our greatest achievement is in suiting our homes to our necessities. Like the snail, the sailor or the gipsy can take his home with him on his wanderings. The arctic snow-hut is as suited to its conditions as are the flimsy houses of Japan, a land of earthquakes. The Englishman in the tropics will build a house very different from those at home; for the sun will shine on it from every point of the compass at some time of the year. He must protect himself from great heat, fierce winds, and

torrential rain, and must provide against the cold nights which often follow hot days.

Few of us have complete freedom to build our houses where we wish, or to plan them as we please. Our economic position, our work, and many other considerations tie us down. So it is important to realize that suitability, rather than spaciousness or elaboration, is the essential element in successful home-making. So many factors come into play that one can rarely hope to achieve the ideal home, but we can at least give consideration to certain things which are essential, and to other things which are desirable, from the point of view of good health. These principles are applicable to the small flat and the cottage, as well as to the mansion.

Our houses are the combined result of many factors. The taste and planning provided by the architect are limited on the one hand by financial consideration, and on the other by the constructive abilities of the builder and the materials which he can supply. Latterly the hygienist has taken a hand; while the voice of the housewife has become more insistent, for, with less space and less service, the practical problems of storage and of easy working become more important. Fashion and convention also play a part, which may be a restricting one.

Here we are primarily concerned with health, but we must not forget that beauty, comfort, and the saving of labour have their claims, and that they too have a health as well as an aesthetic value. All these must be considered when the architect, the builder, and the hygienist pool their knowledge and their resources to construct the ideal healthy home. Each must contribute his quota in fair proportion, not overshadowing the demands of the others. Though past experience and sound tradition cannot in practice be safely ignored, modern life and modern knowledge call for a restatement of the problem, and a loosening of the bonds of convention.

The home of the cave-dweller gave him some degree of security and shelter from the rain and the cold winds. It was a place where he might keep his goods and store his food, and where his young might be reared. We have learned to build our caves where we will, and to elaborate them, but their main purpose is much the same. Our stock of goods and chattels has increased, and domestic labour has become more complex, so that we use and inhabit our houses more. Unfortunately the protection we have secured has brought some evils in its train. In depending on this protection we have to some extent lost our natural powers of reacting to extremes of weather and temperature. In excluding the wind we have excluded much of the sunlight which is a tonic and an aid to our bodily processes and development. In seeking warmth we keep out fresh air. We herd too closely together. Many of us live in houses which through bad construction or through age have

become damp and insanitary. Thus our 'protecting houses' are the cause of much disease. Damp houses have a definite association with rheumatism, as has overcrowding with many infectious diseases. The dry, still, vitiated atmosphere of unventilated rooms makes our mucous membranes particularly vulnerable to infective organisms. Overcrowding makes infection easy. The sudden transition from overheated air to the cold outside may, with our slowed-down reactions, give the chill which precipitates disease. Lack of air and sun brings debility and fatigue, and lowers our resistance. So, although we cannot now do without houses, they must be healthy ones.

Our houses vary so much that they can hardly be considered in detail, even from the health point of view alone. We can only establish a few general principles, and consider a few defects that should be avoided. These principles must be applied as far as circumstances permit, whether the house be large or small, whether we are building a new house or adapting an old one. In every case we must bear in mind that our houses must be suited to healthy and comfortable life the whole year round. We do not here have the extremes of heat and cold that exist in many countries, but our climate varies considerably, and we are subject to marked changes from day to day.

Site and Foundations

In building or choosing a house one should consider the site and the soil on which it is built. All soil contains much air in its upper levels, and below that water. The ground water is the accumulated rainfall, the water percolating down through the soil until it comes to an impervious layer, on which it rests or, more usually, flows. This ground water naturally follows the same laws as water elsewhere, finding its level, and flowing down subterranean slopes of impervious strata to any available outlet. We may imagine a series of lakes, streams, and rivers in the ground beneath us, and we must remember the possibility of stagnant pools where there are hollows in the impervious layer below. The height of the level of the ground water depends on the depth below the surface at which the impermeable layer lies, and on the rate at which the water can flow away down its natural gradients. In marsh land the ground water comes actually to the surface, and in alluvial land it tends to be very near it. Such soils are naturally unsuitable for house building, and if used at all, piles must be sunk or arches built on which to place the foundations.

As the ground water consists of accumulations of so much of the rainfall as has not evaporated from the surface or become absorbed by vegetation, its level varies with the seasons. In some places a connection appears to have been established between variations in its level

and the occurrence of epidemics of enteric fever and other diseases. Certainly too high a level of ground water is prejudicial to health. A high level of five feet below the surface is dangerous: a high-level mark of about fifteen feet down might be considered satisfactory.

Above the water itself there is still moisture, and the interstices of the higher soil are filled by the ground air. As the water level changes the quantity of ground air varies, as it is continually being driven out of the soil or being drawn in. The quantity also varies with the nature of the soil; loose permeable soils such as sand and gravel containing much ground air.

Surface soil has been called a natural laboratory. Much organic matter drains into it or is washed down by the rain. Vegetable decay is always occurring. Every kind of soil contains countless bacteria, many of which are engaged in aiding the processes of decomposition; others take part in the forming and storing of nitrogen; and these chemical processes cannot take place without the liberation of gases and other effluvia. The ground air, therefore, contains much moisture, and carries emanations from decomposing material, varying in amount with the purity of the soil. 'Made soil,' the result of filling up land by the dumping of rubbish and refuse, has naturally many impurities in its ground air, and such soil is quite unsuitable for a housing site.

Speaking generally, one should choose for house-building a situation that is warm, dry, fairly elevated, and on a gentle slope. Trees form a useful shelter from prevailing winds, but should not be too near the house, as they exclude sunlight and promote dampness and air stagnation. The soil should be dry and porous, with a low water level and reasonably pure ground air. In this country gravel and sand, being both warm and porous, are the best soil. They contain much air, however, so they become unsuitable if there is much pollution. Chalk is porous, but somewhat cold. Clay is both cold and damp, and with it there is much shrinking and expanding, sometimes with cracking of the surface soil. Buildings should not be built on two different kinds of soil, as these react differently to atmospheric changes, and subsidences may occur.

Steps must be taken to prevent water and ground air from entering a house. When a house is heated, particularly in winter, when the surrounding soil may be frostbound, there tends to be a constant inward and upward current of ground air, impure and bearing much moisture into the house. The whole of the foundations must, therefore, be covered with an impermeable layer, consisting usually of at least six inches of concrete. Paving laid round the outside walls is also advisable. If there are no watertight cellars beneath the house the lowest floor should be two feet above ground level, the space below being well ventilated.

The unhealthiness of damp houses is a matter of common knowledge. To prevent the passage of water from the soil one must protect the walls as well as the floor, for all our ordinary building materials are capable of conveying water. It is usual to build the walls with a damp-proof course, which forms a watertight layer a little above ground level. This may be made of slate embedded in cement, or of a row of special glazed and impervious bricks, which are usually ventilated. In the same way steps must be taken to protect the outside of the wall from damp at any point where it is in contact with the soil. The walls themselves must be kept weatherproof, brickwork being pointed and woodwork painted whenever necessary. Very exposed walls may require a waterproof coating of some material such as Portland cement. Defective roofs and rain-water pipes and gutters are a frequent cause of dampness.

Sanitation

It is difficult for us now to realize the many dangers to health that have been abolished by modern sanitation. Water-carried sanitation is almost universal, at any rate, in urban areas, and the cesspool, the pail-closet, and the open sewer have largely disappeared. The technical side of sanitary work must be left to the expert. His aim is to arrange that waste matter shall be removed from the house as cleanly and as rapidly as possible, to be treated suitably elsewhere. For a long time our system aimed at the assembling of all sanitary appliances as near an external wall as was convenient, so that all pipes passed outisde the house as soon as possible. Waste, soil, and rain-water pipes were arranged on separate systems, and waste and soil pipes were trapped at their source and at their entry to the sewer. In recent years some modification of our plans has been necessary. The demand for individual sanitary accommodation has increased greatly, and it has been found that in large houses, hotels, and blocks of flats the old system of pipes and intercepting chambers was complex and very costly, as well as difficult to accommodate without spoiling the building. As a result there is now a tendency to revert to a one-pipe system, and to permit more internal drainage. Modern artificial ventilation also makes possible the provision of internal lavatories in some cases, releasing the external wall space once occupied by these rooms. We rely nowadays on sound construction and on good flushing and effective ventilation of all pipes. Traps at the source are still necessary to cut off the drain from the room, but modern architects simplify drainage by cutting out many of the old-style intercepting chambers.

The wider use of coke stoves for water heating is facilitating the disposal of household refuse. If such stoves are properly used there is no refuse liable to decomposition which cannot be burnt. As a result,

the dustbin, so often to be found outside the kitchen window, need no longer be a source of smell and an attraction for flies. Incidentally there is a decrease in the demand for refuse removal, a costly public service.

The use of refrigerators greatly helps in the hygienic storage of food. Increased knowledge of the dangers of infection or contamination of food has made us more fastidious with regard to its clean handling and its protection from dust and flies. Summer diarrhoea in children, at one time a frequent cause of infant mortality, has become rarer and rarer as our standards in food protection have risen.

Ventilation

It has been said that one of the purposes of our house is to provide us with warmth beyond that which we generate ourselves. This we must arrange with care, lest in providing warmth we deprive ourselves of the fresh air which is so important to health.

Free air is, normally, very constant in its composition, its main constituents being oxygen, 20·9%; nitrogen, 78%; and carbon dioxide, 0·03%. In towns stagnant patches exist where there is little air movement, and as much as 0·06% of carbon dioxide may be found. In such spots back-to-back houses or houses in courts and narrow alleys may be taking in stagnant air which is already impure. Vitiation of the air inside houses occurs through the expiration of carbon dioxide by people and animals. Combustion also adds carbon dioxide to the air and uses up oxygen. Plants take up the carbon dioxide and give out oxygen in sunlight, but at night the process is reversed, so that they too may cause vitiation of the atmosphere of a room.

The percentage of carbon dioxide in a room can be used as an index of the amount of pollution. If it reaches 0·06 the atmosphere has a feeling of stuffiness that is appreciable to our senses. But it is not this gas which is harmful to health. Even in a badly overcrowded room the percentage of carbon dioxide is rarely great enough to cause any serious effect on health; indeed, excess of this gas stimulates breathing, so that we easily maintain our supply of oxygen by taking in more air. The feelings of fatigue, depression, restlessness, and perhaps headache which arise in an impure atmosphere appear to be due to the absence of movement in the air. An electric fan moving even vitiated air gives a sense of relief. Air movement lowers the temperature of the room, and carries off moisture and the emanations of our bodies; and by stimulating breathing and aiding evaporation from the skin it removes the feeling of stuffiness.

The purpose of ventilation, then, is not only to bring a constant supply of fresh air, but to do so in such a way that there is, in the room, constant movement of volumes of air.

Movement of the air within our houses is caused in three principal ways. First, the gases in the air follow natural laws which cause their diffusion until the mixture in a given volume of air is similar to that in the surrounding atmosphere. Next, wind acts on the air in a house directly by blowing into apertures, and indirectly by blowing across a chimney pot or open window. In this second case a process of aspiration may draw out the internal air. Thirdly, the difference in weight of volumes of air causes their movement. Heated air expands, it therefore grows lighter, and rises, being replaced by cooler air. As our heating systems may cause both air pollution and air movement they must be considered in relation to ventilation.

The amount of air which we inhale varies with our age, our size, and the work which we happen to be doing. Various scales have been worked out as to the amount of air space per person required in differing circumstances. Perhaps four hundred cubic feet per person in rooms used both day and night, and three hundred cubic feet in rooms used only for sleeping, may be taken as a minimum. This applies to rooms where efficient ventilation exists, so that the atmosphere of the room can be completely replaced three times in an hour. In calculating air space for official purposes it is usual to omit the space above twelve feet. In fact, the changing of the atmosphere is more important than the actual room space; for the air in even a large room would soon become vitiated without ventilation. It is, however, easier to ventilate a large room without the occupants becoming too conscious of the air movements. If our rooms are small we must pay particular attention to the arrangement of our ventilation, as too frequent changes of the room-atmosphere, when the incoming air is cold, are apt to be uncomfortable.

For efficient ventilation we must have a fresh-air inlet, and an outlet for the removal of impure air, of which the latter is the more important. If the used air is removed it will always be replaced. Air passes in under doors, between floor boards, round windows, and even through our walls. But this may be dusty air or impure air from other rooms, and there should be a definite entrance for fresh air from outside.

One of the best agents for the removal of impure air is the open coal fire. Above this a column of hot air is continually passing up the chimney, and air is drawn from the room to replace it. Those systems of artificial ventilation which depend on the extraction of used air from buildings, rather than the driving in of fresh air, act on the same principle as the coal fire.

The best inlet for natural ventilation is, of course, the open window. This should be well open. If air is being removed it will be replaced, and a small opening simply means a fiercer and narrower stream of cold air. If the opening is quite insufficient there will probably be a draught, perhaps from under the door. 'Draughts,' as distinct from

the slow and steady diffusion of fresh air, are harmful and unpleasant. They cause excessive cooling of single parts of the body, instead of the body as a whole, and such partial chills lower resistance. Where the inlet to a room is larger than the outlet there is less likelihood of draughts. These are also avoided if the incoming air is able to circulate freely through the room, instead of passing in a direct current from inlet to outlet. This also prevents the occurrence of stagnant corners in the room.

One must always remember that hot air rises, cold air falls. The outlet, therefore, should be as high as possible. Theoretically the inlet should be very low, but when the incoming air is cold it is probably best to let it in a little above head level, and direct it upwards, to avoid discomfort. It will come in contact with the hot air above and fall to a lower level.

Differing methods of heating may give warmth by radiation, as in the coal fire; by convection, as in the hot-water radiator; or by both methods. Radiation of heat causes the gradual spread of warmth over the surfaces of objects in the room; convection heats volumes of air which themselves pass about it. Radiators and hot-pipes cause air movement, but do nothing to remove impure air. Heating apparatus which depends on combustion should be provided with a flue to remove waste products, which flue will also act as an air remover. As has been said, the open coal fire is the best of these ventilators. It is an agreeable form of heating, but a somewhat wasteful one, for much of the warmth is lost up the chimney. Probably none of our ways of warming ourselves is injurious to health if in our search for cosiness we do not forget the need for ventilation. Those ways which depend on convection may make the atmosphere too dry, while overheating has a fatiguing and unhealthy effect. 60° F. is a good average room-temperature.

The success of the open-air treatment of tuberculosis and other diseases has done much to dispel the old fear of fresh air, and especially of night air. Many people have proved for themselves in the course of treatment that one can, with benefit to health, sleep on a balcony or veranda, or in a garden shelter. Warm coverings and protection from rain are, of course, necessary. There is no reason why this treatment should be reserved for the sick, and we may well consider whether some such arrangement is practicable for ourselves. Even where it is not we can at least all throw our bedroom windows wide open when we go to bed.

At various points in this book we have made reference to the importance of sunlight to health, and we must remember this when considering the selection of our ideal home. Good large windows are very desirable, and often the addition of a bow window will make all the difference to a room both in looks and in health. An over-large

area of window glass may be blamed for coldness in winter and excessive heat in summer, but we must make sure that the windows are big enough, and that they are so placed as to permit of real penetration of the room by light. And having got good windows, we must not, in our desire for privacy or for decoration, shroud them so completely that they are useless. It is quite possible to secure privacy with a minimum of light exclusion.

In England the north and north-east aspects of a house are cold, the southern aspects warm. The north-west and south-west aspects are usually windy, and there may be driving rain from the south-west. The south-east aspect is dry and mild. Ideally, one would place one's living-room facing south-east, one's bedrooms east to get the morning sun, one's larder on the cold north side. In practice this may not be easy. Rooms cannot be isolated, but must be taken as a part of the house as a whole. All the bedrooms can hardly face east. The room to the south-east may not be in other respects the most suitable living-room. Yet there is no doubt that we do tend to be tied down by certain conventional arrangements of rooms, and we may consider it worth while in certain cases to avoid these traditional plannings. In too many of our streets the houses all conform to one type while it is quite obvious that the arrangement which is best in one house will be wrong in the similar building facing it across the street.

Cleanliness

Most of us in these days have smaller houses and less domestic help than had our grandparents, and we must learn to adapt our houses accordingly. Fortunately our modern taste goes in the direction of smaller and simpler furniture. In a small house, one must conserve what space one has, and avoid all obstruction to light and to moving air. Large ornate pieces of furniture collect dust, and make more labour; heavy curtains and hangings shut out light and air. Perhaps their only advantage is that they deaden sound, of which there is plenty these days.

Cleanliness has real hygienic value, and an orderly and well managed home brings rest and contentment to its occupants. But there is no reason why these things should not be won as easily as may be. The modern housewife may have little help, she may have outside work, and she will certainly have outside interests. Let us lighten her labours as much as we can, and try to save her from weary drudgery. Let us cut out corners and crevices in our house construction, and give her surfaces that are easily cleaned, and implements which keep her from her knees. Every labour-saving device is an aid to health, and we should think kindly of vacuum cleaners and stainless metal and running

hot water in the tap. We should be glad that there are fewer oil lamps and cumbrous kitchen ranges, and that the chemist and the mechanical engineer have supplied a hundred little aids that make housework easier and quicker, without being less efficient.

Town Planning

We must not fail to see the wood for the trees. Just as we must plan our rooms so that they fit in with the rest of the house, so we must, in urban districts, think of our houses in relation to the town as a whole. In recent years we have come to hear much of 'town planning,' but the idea is probably older than the term.

Though many towns look as if their development had been entirely haphazard, this has seldom been the case. The grouping of houses is controlled by topographical considerations, and by the attractions of various centres. The civic buildings, the harbours, the market place, and the railway centre make a focus for the commercial classes; just as the university, the law courts, and the cathedral do for certain professional groups. There is a tendency for certain trades and callings to congregate together, as—to take London—in various parts of the City or in Harley Street. The convenience of rapid communication and of working in a district known to be devoted to the particular occupation outweighs the disadvantage of competition at close quarters; and residences in towns bear some relation to these business groupings. The wealthy build their houses in the most desirable district; in this country, frequently the west end of a town.

The growth of public services has had an effect on the arrangement of our houses. The prospective builder must consider the position of roads, and the possibility of benefiting by water, lighting, and sanitary undertakings at reasonable cost. Large crowded areas demand parks and open spaces. The creation of new roads or the erection of important buildings is more readily undertaken where ground is cheap, and so poor-class property which has heretofore occupied it is swept away.

We now plan ahead for these improvements, instead of letting them arise as by-products of other events. We try to think of a town or a district as a whole, and to preserve or improve its amenities. We try to clear unhealthy areas. We regulate offensive trades or banish them from our towns. We control the height and the nature of buildings so that other residents are protected. We make broad roads, which not only help our increasing traffic problem but make passages for air currents, and strips of sunlight. We look ahead at our ever-expanding towns and plan parks and green belts among them. And thus we may hope to obtain healthy towns as well as healthy houses.

X—THE TOWNSMAN

THE artificial circumstances of life surrounding the town-dweller offer some special problems with which his country cousin need not concern himself. These problems may be conveniently discussed under the heading of the special sense organs: skin, eyes, nose, ears, mouth; for it is these organs that bear the stress, as it were, of the change from natural and even primitive surroundings to those in which all the modern mechanical miracles are treated as a matter of course. The townsman reacts even to weather conditions in a different manner from that in which the agriculturist reacts; his days are spent indoors instead of in the open, and his nights, even when he is middle-class and steady-going, do not invariably conform to the early-to-bed rule. The townsman can keep well if he will, but it is not so easy for him as it is for the plowman. It is the details of some of the points of difference that we now proceed to discuss.

CARE OF THE SKIN

The skin or integument, the largest organ of the body, combines the functions of ordinary sensation, protection, secretion, heat regulation, and, to some extent, respiration. For the due performance of these important functions it is essential that the skin be kept clean. In the country it keeps itself clean; in the town the atmosphere is laden with dirt particles which penetrate even heavy clothing and clog the pores. The skin of the town-dweller requires to be kept in training. In health it contracts under cold influences and relaxes under warm. The rapid transition from an overheated atmosphere to a very cold one, as may occur in coming out of a theatre, very easily leads to an undue loss of heat unless the skin is taught to react quickly to heat and cold. In a general way this is best done by wearing as few clothes as possible, and by frequent cold, and occasional hot, baths. It is a great mistake to coddle the skin. It should be kept clean and thoroughly toned up.

EXERCISE

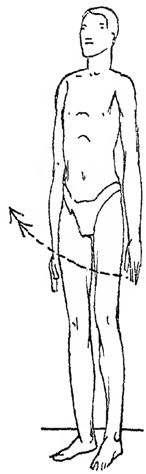
The secretion of moisture from the skin, called sweating or perspiration, though primarily a measure of heat regulation, is a depurative procedure of great value. It is important to realize that this purifying effect is more marked when the perspiration is the result of muscular activity than when it comes from externally applied heat, as in a Turkish bath. The muscles in contracting burn up the poisons and excrete the ashes partly through the skin. The active countryman, as a rule, expects to perspire when he takes exercise, but the townsman does not. The countryman is always prepared to sweat, whereas the townsman is

obliged to dress specially for the occasion. In his ordinary formal business attire, he is forced to avoid perspiration; it is only when he has donned flannels and an open-necked shirt that he feels prepared. How to get exercise which falls short of exciting perspiration is always a problem for the town-dweller, and its solution must always be an individual matter. If a man lives at some distance from his office it is a good plan to try to walk some of the way home. Some people try walking to the office, but they soon give it up because of the obvious inconveniences of arriving wet, or hot and tired, against which it is not possible to provide. The walk home has no such drawbacks, because a change of clothes can always be effected. 'Physical jerks,' as they are called, have many merits for town-dwellers of both sexes. There are many systems on the market; the best of them lay special stress upon the exercise and development of the muscles of the abdomen and lower limbs. The muscles of the legs can, and should, be kept in good order by walking and various games. It is clear that man would not have been provided with such large and powerful muscles as those which adorn his lower extremities had not Nature intended them to be fully employed, and this, for most townsmen, is not an easy matter.

The importance of well developed abdominal muscles may be realized from the fact that these muscles constitute the only barrier to the sagging downwards and forwards of the organs contained within the abdominal cavity. This ugly dislocation is of such common occurrence among townspeople and is attended by such disastrous results, physiologically and aesthetically, that ingenuity has been exhausted in the invention of belts and supports and corsets of every shape and material. When such supports become necessary it is doubtless well to appeal to them. But they never ought to be necessary; for they constitute a confession on the part of the wearer that he or she has lived very unhygienically. To restore a lax and protuberant abdomen to normal proportions is a matter of diet as well as exercise: to preserve it from becoming lax and protuberant is usually a matter of exercise alone. The best outdoor exercises with a special effect upon the abdominal muscles are horse-riding and boating, and these are not as a rule easily accessible to town-dwellers. A good system of physical jerks with special appeal to the abdominal muscles ought therefore to be cultivated and persevered with—dull as such systems admittedly are—by all those condemned to town life.

Exercise is important not only to the general well-being; it has particular applications. It is, for example, well to remember that the stiffness of joints which so often comes with middle age is due largely to want of exercise. If muscles are not used, then joints are not moved, and if joints are allowed to remain inactive a species of rust collects about them, limiting movement and causing the pain which people call rheumatism. Also, it is to be remembered that muscular

contraction is one of the forces by means of which the circulation of the blood is carried on. The veins of the trunk and lower limbs are obliged to return the blood towards the heart against the force of gravity, and this they cannot do efficiently unless they have the support and assistance of well developed and well exercised muscles.

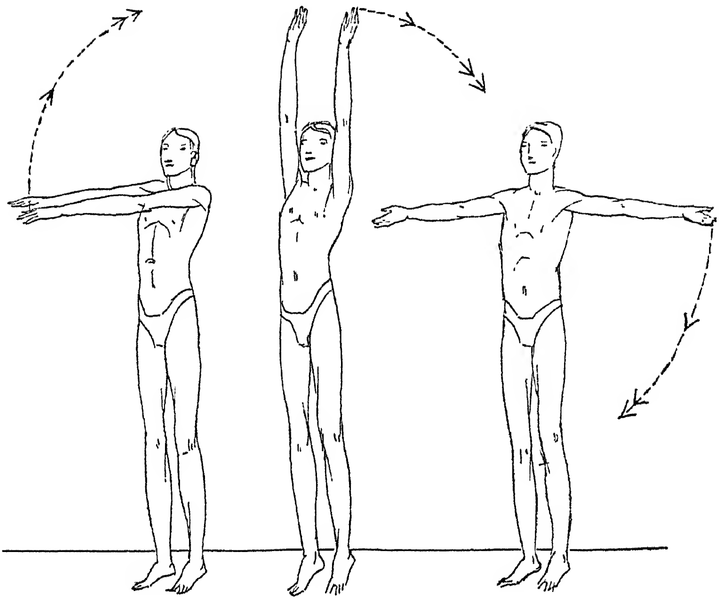


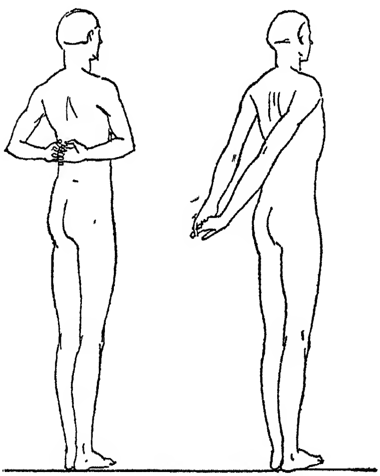
The exercises illustrated here make up a set suitable for any one who lives a sedentary, town life, and wishes to keep himself in reasonably fit physical condition. They should be performed in the morning, preferably while the exerciser is unclothed, and, whenever possible, with the windows open. Before the morning bath is a good time to do them; and they should never be skipped, even though lack of time may sometimes cut them down. It is better to go through the routine, lessening the number of times given to each exercise, than to leave any of them out entirely.

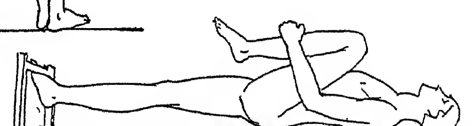
Exercise 1. Stand with the head up, chin drawn in, chest well forward and abdomen in. Hands to the sides. Then raise the arms forwards with the palms down; stretch them up, at the same time rising on tiptoe and inhaling. Stretch the arms sideways and lower them, palms turned to the back; lower the body to the heels, and exhale. Repeat the exercise twenty times.

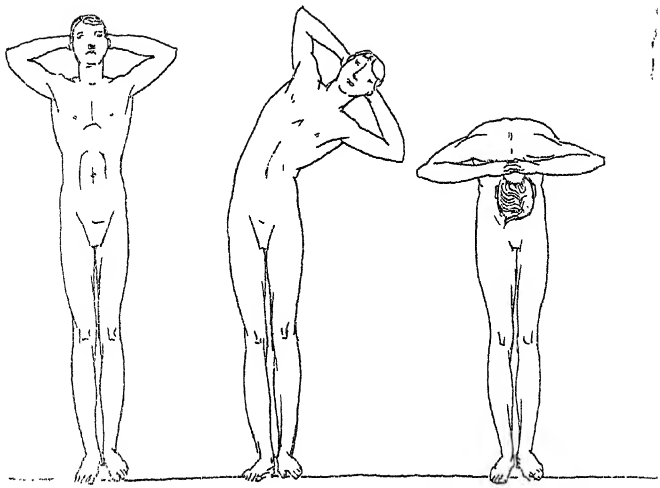
Exercise 2. Stand with head and body as before; the arms behind the back, the hands resting on the small of the back, with their fingers interlocked, palms out. Straighten the arms, at the same time turning the palms in whilst keeping the fingers interlocked. Swing the straightened arms downwards and then up and out from the body, hands still locked. Then twist the arms and shoulders round, and bend the head back. Keep in this position for a moment, then slowly reverse all the movements. If at first the fingers tend to come unlocked, use a loop of cord instead of interlacing them, until the other method becomes practicable. Repeat twenty times.

Exercise 3. Lie on the back with the hands on the hips; then raise the legs alternately, bending the knee so that it touches the abdomen. With the hands then clasp the knee and press it on to the abdomen as firmly as possible for a few moments. Repeat this twenty times, with the legs alternating.









Exercise 4. Stand as in the first exercise, but with the arms extended sideways, and the hands clasped behind the head. Keeping the arms and head in their relative positions, bend sideways from the waist, first right, then forwards, then left, and then back, returning to the first position; so that the head describes a circle. The knees should be straight, and the feet together. Repeat this exercise in sets of five times each way, twenty times in all.

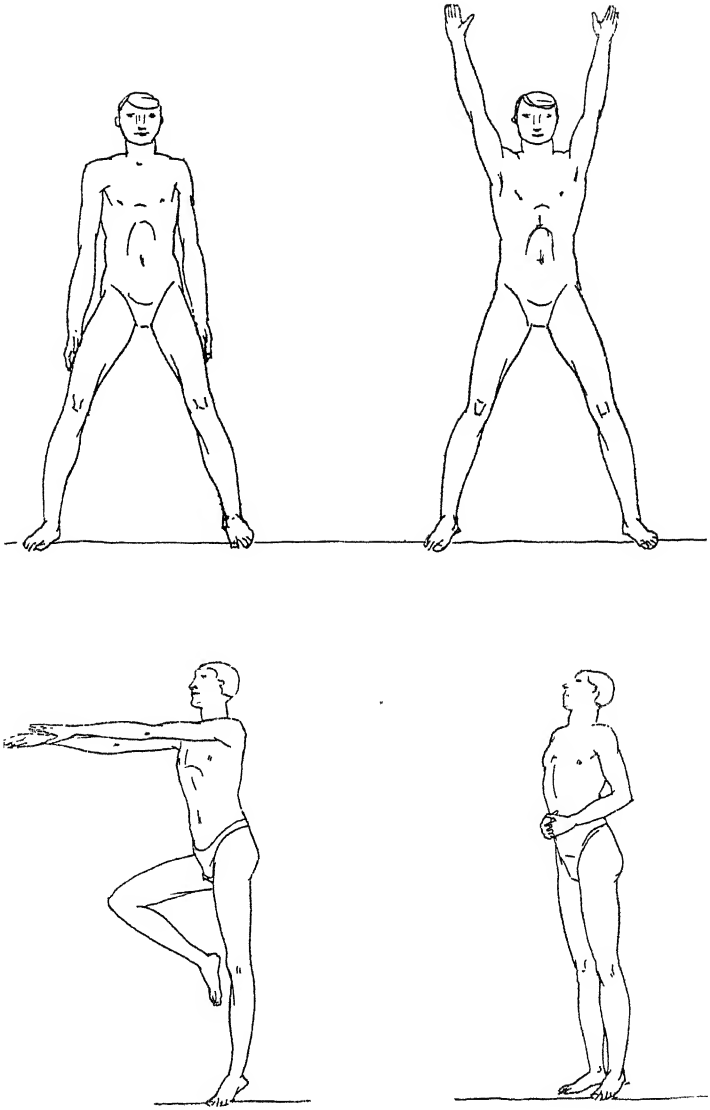
Exercise 5. Stand as in the last exercise. Bend the head and elbows back as far as possible, strongly; then bring the elbows forward, relaxing the muscles. Repeat twenty times.

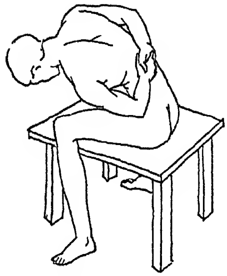
Exercise 6. Stand with the arms at the sides, but the feet from twenty-five to thirty inches apart. Stretch the arms sideways till they are above the head, then bend forward till both hands touch the floor. Slowly rise, and bring the arms to the sides. Repeat this twenty times.

Exercise 7. Stand with the arms stretched forward; then swing them out at the same level sideways, then up above the head; at the same time moving the legs as if running, but keeping on one spot. The steps should be at the rate of about three to the second, and the arms should be held in each position for fifty steps.

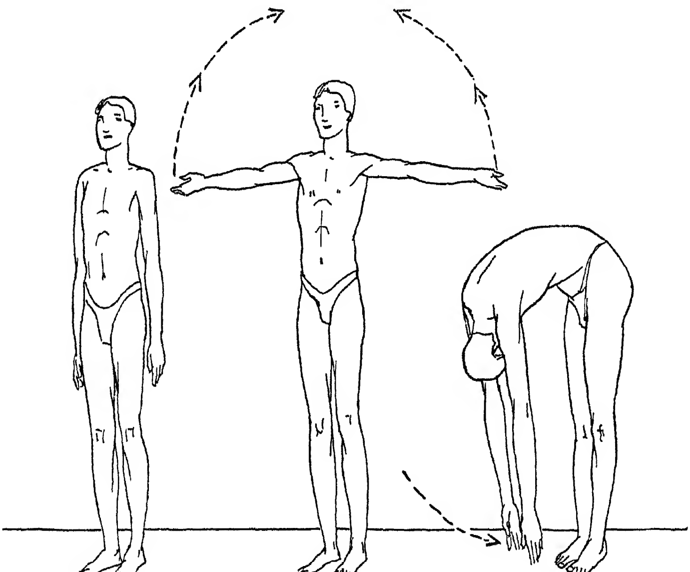
Exercise 8. Stand with the hands firmly clasped on the abdomen, and breathe in, at the same time strongly pressing in the abdomen; then breathe out, and allow the muscles to slacken.

THE TOWNSMAN





Exercise 9. Sit on a stool with the hands clasped behind the back. Then bend strongly forward from the waist, then to the right, backward, to the left, and so up to the starting position, so that the body describes a circle. Repeat this twenty times.



Exercise 10. Stand with the arms to the sides; then raise them sideways till they are stretched above the head, while breathing in. Bend the body forward with the arms still in a line with the trunk, till the hands touch the floor; rise again, and lower the arms to the sides, while breathing out. Repeat this twenty times.

Clothing

In the matter of clothing, town-dwellers are too apt to permit the stupidity of fashion to impose real fetters upon them.

All clothing should be worn loose. Tightness anywhere interferes with muscular action and impedes and impairs the circulation of the blood. Even sock-suspenders are objectionable, and garters are even more so. Tight boots and shoes are objectionable, even more because their evil effects are not always easily recognizable. Fatigue, attributed to other causes, is often due to the undue cramping of the feet, helped by tight socks or stockings.

The part of the body to which constriction is usually most firmly and diligently applied is that which above others should be free from any semblance thereof, namely, the neck. The narrow isthmus which connects the head with the trunk contains a large number of very important structures: muscles, arteries, veins, nerves, and glands; the main air-passage, the trachea; and the main food-passage, the gullet. These are all closely packed in front of the bony spinal column. The blood-vessels and nerves here form the connecting links between the brain and the rest of the body, and are in this respect the most important organs in the body, so that their full freedom of activity should on no account be interfered with. Yet modern man so arranges his neckwear as to bind all these organs against the unyielding spinal column. The degree of compression to which some will submit whilst loudly protesting that there is no compression at all, is sometimes very astonishing, presumably because the constriction has been gradually applied. If we look at the costume of those who are really active in sports—cricketers, tennis-players, oarsmen—we see that their necks are always perfectly free; yet the people who are engaged in brain work, which is work *par excellence* requiring a good supply of blood to the brain and a free drainage therefrom, are, above all others, those who wear the highest and tightest collars. If you ask a person thus trussed and corseted about his neck to bend down as though to lace his boots, the sudden and alarming congestion with which his face becomes suffused will prevent you from repeating the experiment. The limp collars, now so often worn, are often even more dangerous than those which are starched; not only because they shrink in the wash, but because those who affect them seem to find it necessary to keep them in place by pulling the tie so tightly as to threaten strangulation. Neckwear which fails to admit one hand quite freely up to the knuckles between itself and the skin, is injuriously tight. It is well to remember that the gaseous exhalations from the skin of the chest, abdomen, and back find a natural exit at the neck. By no means the least objection to a tight collar is that it imprisons these unwholesome gases.

Care of the Hair

The health of the hair, like the health of every part of the body, depends upon a pure blood supply. If hair is to be kept in good condition it must be stimulated. In the absence of stimulation the roots become apathetic and eventually atrophy from inanition. When women still wore long hair the weight of this itself stimulated the roots, and the necessary brushing and combing reinforced the stimulus. For this reason they rarely grew bald, whereas their husbands and fathers who wore their hair short and kept it in its place by means of greasy lotions, which obviated the necessity for more than a very perfunctory brushing, grew bald early. Now that women bob their hair and shingle it, they too are likely to become bald unless they remain as attached to the hair-brush and other means of stimulation as they were when they still retained their tresses. Threatening baldness should be met not by so-called stimulating lotions, but by vigorous friction with brush, comb, and finger, and by moving the scalp on the underlying bone. All this takes time and energy and perseverance: but there is no other way, no royal road.

The pressure of the hat is sometimes cited as a cause of baldness; but, in fact, hats are seldom on the head long enough to do any real damage. The direction in which hats are calculated to do harm—male hats—is in that of harbouring dirt, and thus of causing infection of the brow and hairy scalp. Men will wear the same hat, week after week, and month after month, perspire in it, and leave it about in all manner of odd places, and never once subject it to any more cleansing process than a perfunctory superficial external brushing. A hat which is worn constantly should be kept clean. The inside leather band should be turned outwards and washed with soap and water at least once a week. Except the hands, the skin of the brow is probably the dirtiest part of the body, and yet very little attention is usually paid to its artificial covering. Even vests are occasionally sent to the wash!

Care of the Eyes

Originally used chiefly for long distance, the advance of civilization has determined that the activities of our eyes should be almost entirely restricted to middle distance and near vision. This supplies the reason for the comparative rarity of perfectly normal vision among town-dwelling children of the educated classes. The structural development of the eye demands that it should, so to speak, be 'brought up' on long-distance vision, just as the adequate development of the bony framework demands that it should be 'brought up' on vigorous muscular exercise and fresh air. The practice of teaching children from

blackboards is better than teaching them from books, but neither is entirely justifiable unless it is freely diluted with practice in long-distance vision. The eye is an optical instrument, and stands alone among the organs of the body in the fact that its adequacy for the task which it is intended to perform can be measured with mathematical precision. The large and ever-increasing number of people who are obliged to wear glasses constantly, testifies not only to the increasing knowledge and skill of oculists, but also, and more emphatically, to the fact that too little attention is paid to the developmental exercise of the eyes in childhood. From the moment it begins to be used as an organ of observation, the present-day eye is given too much near work and too little distance work, with the result that it develops, structurally, along faulty lines, and when fully matured requires glasses to correct its faults.

Where the eyes are concerned it is a fact that minor errors are often more serious in their results than gross errors. Gross errors are easily detected and corrected, whereas slight errors are not. If a child cannot see the figures on the blackboard his inability soon becomes apparent; but if his next-door neighbour is able to see them at all it generally goes unsuspected that he may be seeing them with difficulty. The latter goes on seeing them, and adjusts his ocular apparatus so as to obtain perfectly clear definition, and this adjustment soon becomes habitual with him. This means that energy which properly belongs elsewhere is being illegitimately attracted to the visual organ, so that although the child sees well, he does so at a physiological cost which it becomes increasingly difficult for him to pay.

The physiological price which a person may thus have to pay for uncorrected slight errors of refraction may take many forms. By far the commonest of these is headache. The headache of eye strain is worst in the morning, on waking, especially if, the night before, the eyes have been severely taxed, as in reading; or taxed in an unusual manner, as at a theatre or a cinema. A picture gallery, indeed sight-seeing generally, is very liable to give rise to the headache of eye strain. The character of the discomfort is usually a dull ache, which attacks by preference the brow, or one side of it, or the back of the head. The pain may, however, be very acute; sharp, cutting, and paroxysmal in quality. Pains of eye strain are often accompanied by an intolerance of light; and in severe cases by vomiting. Many so-called 'bilious attacks' are ocular in origin.

Having regard to the amount of the world's work which nowadays demands complete ocular efficiency, and considering the trick which slight errors have of masquerading as defects in other organs, it is a wise rule which bids parents and guardians satisfy themselves by expert advice that the eyesight of their children and wards is as it should

be, before these are set to serious study. Many an unexpected failure in examinations which has been attributed to idleness or lack of application has in reality been due to some slight ocular defect. A great deal of indefinable *malaise* in adults, to say nothing of seeming defects in character and even in morals, has been found on investigation to depend on the same unsuspected cause. Eye strain is undoubtedly responsible for a large measure of wretchedness in civilized life which a little forethought and understanding would easily remove. It is a by no means uncommon cause of insomnia. It is one, at any rate, of the causes of sea-sickness—some say, the principal cause. The agricultural labourer does not suffer from eye strain.

Care of the Ears

What are commonly called the features of the face—eyes, nose, mouth, and chin—are generally regarded as revealing certain mental and moral characteristics, but none of them is in reality so tell-tale as is the external ear. The lobe of the ear, for example, is peculiar to human beings, and represents a high grade of development. It is, nevertheless, completely absent in a large number of people; an absence which should thus suggest—though not prove—a low capacity. Another sign which suggests a measure of degeneration is the presence of the little elevated tubercle, which is not infrequently found near the upper part of the margin of the ear. This, according to Darwin, is the vestigial survival of the tip of the pointed ear found in most of the lower animals. Deviations from the normal human ear are also to be seen in very large ears, in ears which protrude at right angles from the head, and in those which are not involuted. These stigmata are more common in women than in men, which may explain the female fashion of covering the ears with the hair.

The external ear is an important index of health. Its colour should in no wise differ from that of the rest of the body. It is, in common with all parts of the head, not infrequently held in a state of chronic congestion by the undue constriction of the collar or the neckband, but even when such purely mechanical causes are not in question the external ear is often deep red or purple, in comparison with the rest of the surface. This is usually due to a chronic error in metabolism most commonly dependent upon constipation. Whenever it is observed it merits attention.

The ear is the organ of fear, and fear, so some say, rules the world. If a person standing on Westminster Bridge, contemplating the Victoria Tower, were to see it suddenly and noiselessly collapse, he would be surprised, but he would not be afraid. If, however, the sudden collapse were attended by a deafening noise, his surprise would be

By courtesy of Miss D. Hartley

A FIFTEENTH-CENTURY HOSPITAL WARD

From the Frescoes in the Hospital of Maria della Scala at Siena

swallowed up in terror. All animals are more easily frightened through the medium of their ears than in any other way. Man has inherited this sensitiveness, for his nervous system generally is more readily affected through his organ of hearing than through his vision or his smell. An unexpected noise, especially if it be an unfamiliar one, will cause him to start. A noise will awaken him from his deepest sleep. In the presence of unfamiliar noises he cannot rest; and the noises arising in the ears themselves, or in the aural nerves, which trouble certain sufferers from deafness are sometimes so intolerable as to drive their victims to suicide.

It is an unfortunate fact that all the material advances in civilization seem to be accompanied by an increase in noise. Setting aside the din of factories and of machinery generally, such blessings as are conferred upon us by telephones, motor cars, aeroplanes, and tube railways are seriously discounted by the great increase in noise which they entail. It is probable that we are able in some subtle unconscious manner to distinguish between necessary noises and those which are unnecessary, and that it is the latter only which 'get on our nerves,' as we say. It is certainly true that unnecessary noises are more wearing to the nervous system generally, than those which are recognized as inevitable. A continuous noise, however necessary and inevitable, is nevertheless very tiring. The fatigue, for example, of a long railway journey is undoubtedly due more to the noise than to any other cause. At least one well-known medical man puts cotton-wool in his ears as soon as he starts on a long journey, an expedient which he finds definitely to lessen the weariness. Incidentally it enables him to plead deafness to his loquacious fellow-passengers. It is therefore obvious that noise, whether or not it causes conscious irritation, has in the long run an exhausting effect upon the central nervous system. Sleep in a railway train is not a refreshing sleep.

The practical outcome of these considerations is that a certain amount of quiet is necessary to every one, every day. In its absence the nervous system fails to obtain the real repose which is essential to its ultimate well-being. If curtain lectures and other domestic amenities render this freedom difficult of attainment at home, the victim should join a club or other institution in which there is a silence-room provided with deep arm-chairs.

Sleep

Nature's method of ensuring quiet is by means of sleep. The physiology of sleep is not fully understood, but it seems evident that it is brought about by cutting off the blood-supply to the brain. It also seems clear that the mechanism by which the cutting-off is effected

includes something in the nature of a stop-cock, so suddenly does one pass from consciousness to unconsciousness.

The amount of sleep actually necessary to any particular person is an individual matter which varies within very wide limits. It may, however, be safely affirmed that just as the majority eat too much, so the majority sleep too much. Too much sleep means that the brain is insufficiently exercised, which is just as bad for the mental side of man as insufficient muscular exercise is for the bodily side. In any case an occasional relative diminution in the usual amount of sleep does no one any harm; indeed, like fasting, it may do a great deal of good. And just as the majority of people hold to very exalted standards as to the amount of food they require, so do they nourish a very special solicitude on the subject of the quantity of sleep they require. And the curious and almost ludicrous fact is that the two, excessive food and excessive sleep, are mutually exclusive. The organism knows, though the individual does not, that the best means of putting up a barrage against excessive food is to deprive the feeder of his sleep, ensuring by this means that the tissues are not overloaded with useless nutritive material. For although such a person is somnolent during the day owing to the determination of blood from his brain to his stomach, he is unable to sleep at night because a provident Nature sees danger in allowing him to do so. The person who is 'a martyr to insomnia,' in eight cases out of ten is a person who is in reality a martyr to his own gluttony. If he were to sleep, as he thinks he has a right to do, he would be undone by a rush of nutritive substances to a system already overburdened with useless material. There would be a turmoil followed by an explosion; that way apoplexy lies. For such people the best sleeping draught is an emetic.

Care of the Nose

The nose has three important functions. The one most generally associated with this prominent organ is the sense of smell, which is in reality the least important of the three. Of the other two, one has a very close connection with breathing, the other with voice production. The sense of smell in human beings is a very attenuated affair compared with that of the other higher vertebrates—except the apes, which have practically no sense of smell. Happily for him, perhaps, a town-dwelling man very rapidly loses what little perception of odours he was originally given, probably because his olfactory nerves are so over-stimulated by the smells and gases of great cities that they rapidly wear out. By the age of sixty, most men have lost all their finer olfactory perceptions.

The function of the nose which is of the greatest importance to civilized man, especially to the town dweller, is the action which it

exercises upon the inspired air. In this country the ordinary air of cities is cold and laden with particles. As this is passed through the nose on its way to the lungs it becomes filtered and warmed, so that on arrival at its destination it is free from gross impurities and is of the right temperature. It follows that every one should breathe through his nostrils and not through his mouth. In order to test an individual's efficiency in this matter it is necessary to block each nostril in turn so as to be certain that deep inspirations reveal a perfectly clear air-way on each side. Some people who breathe through their noses in ordinary quiet conditions are nevertheless obliged to open their mouths when taking exercise or during sleep. Such people have not fully patent nasal passages. The penalty, which must in the long run be paid by a town-dweller for even a partially occluded air-way, is chronic bronchitis and the other troubles of the air passages which are provoked by cold unfiltered air.

Having regard to the fact that the atmosphere of large towns is usually heavily laden, not only with tangible impurities, such as coal-dust, but with intangible poisons, microbic and chemical, it is highly desirable that the delicate and sensitive mucous membrane of the nostrils should be kept as clean as circumstances will allow. There are hundreds of people who diligently clean their teeth, who never dream of applying simple soap and water to the inside of the nose. Every one should wash the inside of his nose whenever he washes his face. If by so doing he can provoke a hearty sneeze, so much the better. Ointments applied to the inside of the nostrils are occasionally useful. Douching the nose is a very useful procedure if the fluid used is of proper consistency and temperature; but it is a procedure which requires an apprenticeship.

Care of the Mouth

The mouth is the gateway not only of the digestive organs, but also to some extent of the lungs, and to a less extent of the nasal cavity and accessory sinuses. It contains the tongue, the teeth, the tonsils, the openings of the salivary ducts, and the orifice of the Eustachian tubes, which lead into the middle ear on each side.

The idea that the state of the tongue is a true index of the state of the rest of the upper digestive tract is firmly fixed in the minds of most people. By the medical profession, however, it is now recognized that a furred tongue is more often due to local causes than to general, and that a so-called clean tongue may be merely the result of the fur having been rubbed off by a meal demanding plenty of mastication. Invalids and people who live on sloppy food often have dirty tongues. A pale,

flabby, tooth-indented tongue, on the other hand, does usually mean debility, and is consequently a matter demanding attention.

There is nowadays very little danger of decayed or defective teeth escaping the notice of a competent dentist, and since this matter has been accorded its proper importance in schools and elsewhere, the health of the public has notably improved. Pyorrhoea, an inflammatory state of the gums, is sometimes due to a spread of infection from the teeth themselves, but more often it is a manifestation of a constitutionally unsatisfactory state of the blood, due often to constipation. Local measures against pyorrhoea are useful enough in their way, but they cannot be wholly successful unless the underlying constitutional cause, which is nearly always dietetic, is properly treated.

The tonsils, which are sentinels whose duty is to defend the air passages against infection, are in town-dwellers kept very busy. They not infrequently succumb under the burden, and become so impregnated with toxins that, instead of being defenders, they act as store-houses and distributors of the poisons they are meant to nullify. They should then be removed. In mouth-breathers the tonsils endeavour to play the part normally played by the nostrils, that, namely, of warming and filtering the incoming air, but as they are not intended for this employment they enlarge and obstruct the passages. It is wise to help enlarged tonsils in their defensive work in foggy and dusty weather by frequent gargling.

Quite close to the tonsil on each side is the small orifice of the Eustachian tube. As this tube leads to the closed cavity of the middle ear, infection of which is likely to be a very serious matter, it is well to promote cleanliness of the back of the throat by simple means, such as gargling at least twice daily, night and morning, with soap and water, sea-water, or some other mild antiseptic. A little reflection will show that, important as cleanliness is in all parts of the body, there is no part where it is more essential than it is in the mouth. The teeth are usually subjected to fairly vigorous brushing, which is no doubt all to the good, but it is to be remembered that in proportion as people eat normal natural foods and masticate them thoroughly, the importance of the tooth-brush wanes. The unsophisticated savage, who lives on natural uncooked foods and never sees a tooth-brush, has beautiful teeth. Nor would gargling and washing out the mouth with soap and water and other cleansing fluids be as necessary as they now are if less sticky, starchy, and saccharine food were consumed. The saliva is itself very antiseptic and cleansing, but ordinary quantities of it are insufficient to cope with the tasks set for it by the quantities of artificial and concentrated foods which are swallowed by most people.

There are three pairs of salivary glands in the mouth; one pair, the parotids, supplies the upper jaw, the other two, the sub-maxillary and

sub-lingual, supply the lower, on each side. The amount of saliva which is poured into the mouth by these glands may amount to several pints in the twenty-four hours. It is always being secreted, night and day, but there is of course a special flush as soon as food is placed in the mouth. It is instructive to note that certain substances increase the flow of this beneficent fluid, whilst others depress it. Among the most powerful depressants are bread and butter, tea, tannic acid, and meat. The most powerful stimulators of the salivary secretion are vegetable acid foods, such as fruits and salads. The proper care of the teeth thus resolves itself into a question of a suitable dietary, and, as one would expect, the fact which emerges most prominently is that the substances which are most suitable to the preservation of the teeth are the natural foods which have undergone the least artificial preparation, and have therefore retained their vitamins; the foods in fact which are most suitable to the preservation of the general health.

XI—OCCUPATIONAL PROBLEMS

Diseases and disorders of body or mind due more or less directly to the occupation of the sufferers offer a wide scope for preventive medicine. Already a very great deal has been done by legislation—in which Great Britain has largely led the way—to promote satisfactory conditions in our factories and workshops, but there is still a great deal left undone, especially along the lines of vocational guidance and accident prevention, where psychological factors have to be considered.

Occupational diseases are brought about by a mixed set of circumstances in many instances. Where a person is working day after day exclusively with some poisonous metal, the effect upon his health may be obvious and direct, and easy to prevent. In other cases the effect of an occupation may be indirect, and not obvious enough to prevent harm being done. The subject can be considered under three main headings:

(*a*) Premises and conditions of work, including the machinery used and the mode of working.

(*b*) Materials used.

(*c*) Suitability of the worker for the work.

Premises and Conditions of Work

It is obvious that such fundamental conditions as sanitation, heating, and lighting, ventilation, air space, etc., will play just as important a part in the workshop as in the home, and problems common to all situations need not be here again discussed. The general conditions of work may be dangerous without being unhealthy. Certain risks of work in any occupation may be the risks also of everyday life, such as electric shock (naturally more likely to happen where high tension is used), motor car accidents, to say nothing of the 'earthquakes, riots, and civil commotion' mentioned in every insurance policy.

LIGHTING.

Lighting is of great importance, as eye strain may soon develop where the conditions do not permit of adequate illumination. Among coal miners, who work in a cramped position with poor light for long periods of time, a curious oscillatory movement of the eyes called 'nystagmus' sometimes develops, but nowadays it is thought that psychological

causes may be in part responsible for this. Where great demands are made upon the eye, as in factories where electric bulbs are tested, or where the work is done at sewing machines, a similar condition is said to develop.

HEATING AND VENTILATION.

Heating and ventilation are closely associated. Firemen, steel and iron workers, and others, carrying out their duties at excessively *high temperatures*, may suffer from severe disturbance of the heat-regulating mechanism of the body, especially if the atmosphere is so humid that adequate loss of heat by perspiration is prevented. Heat stroke, severe collapse, and prostration occur, with sometimes severe degrees of 'cramp' and heart weakness. In connection with the weaving of cottons and other textiles it is thought to be essential to have the atmosphere warm and moist. Workers in such conditions may suffer from severe discomfort if the temperature is high, and it is also held that such people are liable to suffer from bronchitis. Another serious effect of heat is that the lens of the eye may become diseased. The constant hot glare of a furnace, in a glass-blowing factory, for example, may lead to the development of cataract, with eventual blindness. A recent occupational disease associated with heat is that found among cinematograph operators who work in a closely confined space, often badly ventilated and full of machinery. The noise of the projectors is said to produce various nervous disturbances, while the unpleasant fumes given off from the electric arc (especially the copper element of the arc) may be contributory to the state of the bodily and mental collapse which sometimes develops.

Low temperature may also be responsible for danger to health. Nowadays there are a great number of people employed in refrigerator store-rooms where frozen meat, etc., is kept, and there are also workers in ice stores and ice factories. Various disorders of the rheumatic type are found to occur among such individuals—including lumbago and neuralgia, while bronchitis and diarrhoea are also not uncommon. Frost-bite has also been recorded in such workers. Much has been done in the modern refrigerator store to protect the workpeople, by insistence upon proper clothing, clogs for the feet, and attention to the floors to prevent dampness. The risk of being shut inside a cold-storage room has been reduced by the provision of bells.

To a less extent many outdoor workers run similar risks as regards low temperature and dampness, but few of the disorders likely to occur are specifically attached to any particular form of work. It is notorious in London, for example, that policemen are specially liable to pneumonia, but whether this is due to the out-of-door work, the type of clothing, or the conditions of the station-life, is not clear. Nor can dampness alone

be blamed for the articular rheumatism from which gardeners and others suffer, since the rheumatic group of disorders was remarkably absent from the men living under terrible conditions of dampness in the European War.

ATMOSPHERIC PRESSURE.

Atmospheric pressure plays an important part in some diseases. Reduced pressures, such as are met with at high altitudes, are responsible for a whole train of symptoms known as 'mountain sickness,' but this can scarcely be regarded as an occupational disorder except possibly among the employees of the air-transport companies. Increased atmospheric pressure, on the other hand, is responsible for a very interesting and important disorder usually called 'caisson disease.' The effects were first discovered and studied in persons working in caissons or diving bells where compressed air is necessary to make work possible under the level of the sea, for example. Sometimes the effects are produced while the pressure is being applied, but more commonly while it is being reduced. The chief symptoms are headache, giddiness, and pain in the ears, with sometimes rupture of the ear drums. In serious cases, vomiting, severe shortness of breath, great pains in the muscles and joints, and nose-bleeding may occur; while loss of consciousness, paralysis, or even death from internal haemorrhage, has at times resulted. These various disorders appear to be due to the fact that under the increased pressure much more gas than usual (from the atmosphere) is dissolved in the blood, and when decompression occurs too quickly this gas comes off in bubbles, at too quick a rate to be got rid of through the lungs, with the results already mentioned. A system of slow decompression in special chambers has been very satisfactory in preventing caisson disease, and there are also nowadays regulations as to the speed at which divers should be allowed to come to the surface.

LOCAL DISORDERS.

Certain types of work may produce local disease in the body. Thus, if the machinery used or the position at work causes any friction on any part of the body, blisters and later 'corns' may develop, and there are many picturesque names associated with such troubles: 'Weaver's bottom'—'Deal-runner's shoulder'—'Miner's elbow'—'Housemaid's knee.' In much the same category may be placed 'Clergyman's sore throat,' which is by no means confined to the clerical profession, being, indeed, prevalent among schoolmasters (where blackboard chalk is a contributory cause), and among bookmakers, where alcoholism may help to set up the chronic inflammation of the larynx, which is the real seat of the trouble. Flat-foot, from which so many nurses suffer, is

thought to be due to the prolonged standing which is considered necessary during their period of training, often combined in the young probationer with ill-fitting shoes. A more humane treatment of the young nurse would do a lot to prevent this.

X-ray dermatitis (inflammation of the skin) has been one of the tragic results of the discovery of this most valuable means of investigation and treatment of disease, and the early workers with X-rays and radium suffered from this malady, which is liable to become cancerous. There have been martyrs in every centre where these radiations have been used, but nowadays adequate protection by means of metal sheets, etc., is being carried out and it is hoped that such disasters will in future be rare. The occurrence of a series of deaths in America among workers who *some time before* had been using radium paint indicates the serious risks attached to this powerful substance.

NOISE.

The noise of modern machinery may produce disorders of hearing which are of importance. What is known as 'boiler-maker's deafness' is apparently due to a slow destruction of the fine nervous mechanism in the innermost parts of the ear. It occurs among those concerned in hammering metal sheets, driving engines, working pneumatic drills, etc., and it is thought that the use of ear-plugs will prevent the disorder.

ACCIDENTS.

Mechanical accidents are among the occupational risks of the modern worker, and accident prevention has received much attention in recent years. There are two elements concerned—the machine and the persons involved in the accidents. As regards the machines, regulations are very strict as to the protection which must be incorporated in the actual construction of the apparatus, and it is probable that there are very few machines where the best possible safety device is not already in use. In other words, not much more can be done in the way of protection from the mechanical aspect. The personal factor is of great importance. Investigations have already shown the effects of fatigue, speed of work, age of the workers, eyesight, etc., upon the occurrence of accidents. More detailed studies suggest that certain people are more prone to be involved in accidents than others. In other words, people may be susceptible to accidents as they are to certain diseases. Poor co-ordination of the muscles, and temperamental instability, appear to be the faults most likely to lead to accidents, and to a certain extent these conditions can be detected *before* accidents have occurred. There may be more logic than appears at first sight in the alleged French practice of arresting any pedestrian who is knocked

down by a motor car! The psychological problems involved in this aspect of occupational disorders will be mentioned later under the question of the suitability of worker for the work.

Disorders due to Material Used

This group of occupational disorders comprises cases of industrial poisoning where poisonous material gets into the system through the food-canal, the lungs, or the skin. A brief account of the principal varieties will now be given.

Poisoning because of absorption through the food-canal may be caused by lead, arsenic, phosphorus, mercury, zinc, antimony, etc. In certain occupations it is held that inhalation of fumes through the lungs is of more importance.

LEAD POISONING.

This is one of the most important forms of industrial poisoning because it is so widespread and because preventive measures hold out great hopes for its eradication. In the manufacture of lead the smelters are prone to be attacked, and it is also common among those workers who turn the metal into the finished article—makers of sheet lead, lead piping, bullets, etc. In the printing trade there is a risk of poisoning by lead among the compositors and other workers. Painters are very liable to lead poisoning on account of the white lead used in their work. In the tinning of iron and the glazing of pottery and in certain parts of the manufacture of glassware, risks of lead poisoning are present. It is thought, nowadays, that a great deal of the metal enters the body by the inhalation of fumes or dust. Women are specially liable to be affected. The principle manifestations of lead poisoning include a blue line on the gums (in the presence of bad teeth), severe abdominal pain (colic), and involvement of the nervous system causing paralysis, especially of the arm-muscles (wrist-drop), and, later, serious disease of the brain with convulsions. Kidney disease may also develop. The preventive measures suggested, and often insisted upon by legislation, in connection with lead poisoning are multifarious. In many instances other less dangerous metals could be used as substitutes, and this particularly applies to the glaze used in pottery and to white paint. Attention to dust and fumes is insisted upon in certain trades, and respirators to fit over the nose and mouth have been recommended. Personal cleanliness is very important, so that the metal shall not accumulate on the skin. Special drinks have been advised, such as one containing magnesium sulphate, or milk, or weak sulphuric acid. In certain industries where the risk of lead poisoning is great, the employment of women is forbidden.

ARSENICAL POISONING.

Arsenic is used in the manufacture of certain paints (e.g. emerald green), in sheep-dip and weed-killer, and in 'shot.' In certain forms of pottery- and glass-making, arsenic may come into the process. Workers in these trades may become affected. The fumes of the deadly 'arseniuretted hydrogen' occur in certain chemical works, and those dealing with skins and furs may suffer from this gas. Fortunately arsenical poisoning in industry has become rare in recent years following strict attention to preventive measures. The metal acts as an irritant in the body, producing severe irritative inflammation of the eyes, nose, and skin with ulceration and pigmentation (increase in dark colour of the skin). Sometimes severe vomiting and diarrhoea occur, while poisoning of the liver, kidneys, and nervous system may happen in severe cases. Prevention is along the same lines as already outlined for lead poisoning. It has proved very effective, especially as regards the manufacture of paint.

PHOSPHORUS POISONING.

In the old days, when matches were made out of yellow phosphorus, poisoning was comparatively common, but since 1910 legislation has attempted to prohibit this variety of phosphorus in match-making with extremely successful results. Phosphorus poisoning may also occur where a special metallic alloy called 'phosphor bronze' is cast. As regards the match industry, the trouble used to come from the fumes given off during the mixing of the material necessary for the non-safety type of match-head. Short of prohibiting the use of yellow phosphorus, these fumes cannot be prevented. A chemical substitute for yellow phosphorus is now used for this type of match, and for the safety-match the non-poisonous red phosphorus is employed. The principal trouble in phosphorus poisoning is a terrible slow destruction of the bones of the jaw, especially if bad teeth are present. This is seldom seen nowadays. The liver is sometimes involved in phosphorus poisoning, while skin troubles and inflammation of the nerves may sometimes occur. Prevention has largely been effected by prohibition. If yellow phosphorus must be used every possible precaution should be taken to deal with the fumes by adequate ventilation.

MERCURIAL POISONING.

Mercury is used in certain industries, as in the manufacture of barometers, thermometers, electrical meters, and 'ultra-violet' lamps (mercury-vapour type). Chemists dealing with compounds of mercury, photographers, taxidermists, gun-makers, and workers in explosive factories may be poisoned by this metal, which enters into the materials they use. A metallic taste in the mouth is one of the first symptoms,

then the gums become very soft and spongy and muscular cramps and tremors occur; diarrhoea, neuritis, and skin troubles may all result. Preventive measures are similar to those advocated for lead. The fumes are heavy in the case of mercury, and ventilators should be near the floor level.

ZINC POISONING.

The workers in crude zinc or in brass or paint or glass manufacture are all liable to poisoning by this metal. 'Galvanizing' and 'tinning' also necessitates the use of zinc. The symptoms include a cough and shortness of breath, indicating that the respiratory system has been an important route of entry. Dizziness, headache, sweating, vomiting, and muscular cramps may occur. In a special disorder known as 'brass-founder's ague' a liability to acute shivering attacks in the middle of the night is present. Preventive measures are as for lead.

ANTIMONY POISONING.

Brass workers, ore smelters, printers, and workers with enamel are liable to poisoning from antimony. Skin trouble and acute abdominal pain are the chief symptoms. Preventive measures are as for lead poisoning.

Dust Diseases

The importance of dust as a cause of occupational disorders has already been mentioned, and in certain of the types of metallic poisons described above it is thought that dust is the way in which fine metallic particles get into the body. Another way in which dust may harm the body is by producing local trouble in the lung. This accounts for a group of disorders known collectively as 'pneumoconiosis.'

In general terms dust produces its local irritative effects upon the lungs, the more markedly the more it differs in chemical composition from that of the human body. Thus, animal dusts, so long as they are free from microbes, produce little permanent damage, unless a state of hypersusceptibility exists, when asthma may occur. Vegetable dusts, as a rule, do not produce much permanent damage, although workers in cotton, felt, and 'shoddy' occasionally suffer from chronic fibrosis of the lungs known as *byssinosis*—much less common now than before preventive measures were instituted. Mineral dusts are the main offenders, and the degree of damage appears to depend largely upon the presence of free silica in the dust. (In recent times an attempt has been made to blame a compound known as 'sericite' rather than free silica itself, but the matter is by no means settled, nor does it affect the main arguments for measures of control and prevention.)

The principal occupations thought to be specially responsible for lung disorders are mining, quarrying, and those connected with the china and earthenware trades. Lung diseases also are thought to be specially common among cement workers, salt workers, steel-grinders, and, in recent years, workers in asbestos. Among miners there are numerous varieties of disease according to the mineral and type of mine. Coal miners suffer from a condition called *anthracosis* in which chronic bronchitis and some slowly progressive fibrous change in the lungs occur. Shortness of breath develops eventually and sputum is coughed up which is actually black from the coal dust present. The disease takes many years to evolve and is not associated, traditionally, with a particular susceptibility to pulmonary tuberculosis, present in some of the other forms of lung troubles to be described below. (A recent investigation among old retired miners in South Wales has thrown considerable doubt upon this immunity, as certain of them were found to have a quiet, almost hidden, type of tuberculosis in the lungs.)

In dry and dusty mines where other minerals are being obtained the disorder which most commonly occurs is known as *silicosis* because it is held to be due largely to the free silica present in the dust. In dry rock-drilling a very high percentage of workers become afflicted; while the disorder is also common among Cornish tin-miners and South African gold-miners. The manifestations appear sometimes after many years, sometimes more rapidly, and consist of extreme shortness of breath, cough, and 'gritty' sputum. There is a grave risk of tuberculosis developing in the lung, possibly because the delicate (and therefore protective) lining membrane of the interior of the fine bronchial tubes and air-spaces has been damaged by the constant irritation of dust particles. *Asbestosis* is a special type of lung disease which has come in for study in recent years. Workers in asbestos factories, after being 'exposed' for at least five years to the dust, develop a cough, great shortness of breath, wasting and loss of weight, and general weakness. Pulmonary tuberculosis is also prone to occur. *Siderosis* is the name given to the same sort of disease, with similar symptoms, which occurs among those engaged in grinding steel. It is sometimes known as 'grinder's rot.'

Prevention of all these dust diseases means keeping the dust under control. In mining, modern methods attempt to keep the dust down by the use of liquid sprays, so that the work is done under moist conditions—rock-drilling is carried out wet rather than dry. In the cotton trade wet methods are also important. In factories, ventilators are usually arranged in close communication with the actual seat of origin of the dust. For example, an exhaust ventilator can be fixed right over a grinding wheel and the metallic particles drawn straight away from the worker. In other trades, work is carried out over

gratings through which there is a forced down-draught. Where such measures are not possible, various forms of respirator-masks may be worn—although it is not always easy to persuade workmen to wear such protective devices. Attention to personal cleanliness is also important, since the dust can lurk in the clothes, in the hair, under the nails, etc., and get into the system even while the worker is away from his risky occupation.

It was mentioned above that animal dust seldom causes harm unless microbes are present. There is one very important and serious occupational disorder, known as *anthrax*, of which infected animal dust is the cause. This is primarily a disease of animals, especially of sheep and cattle, and occurs all over the world. In the human subject it is almost confined to workers in hides, hair, and foreign wool. It occurs, though rarely, in butchers, and from time to time infection from a shaving brush is reported. The commonest type of trouble is what is known as a 'malignant pustule'—a sore occurring on the face, back of neck, or arms, among men who have carried hides on the back and rubbed some of the infecting microbes into the skin. Unless treatment is promptly carried out, blood-poisoning commonly occurs, frequently with fatal results. A rarer variety occurs when the anthrax microbe gets into the lungs and produces what is known as 'wool-sorter's disease,' a sort of pneumonia generally fatal in less than a week. Preventive measures include the control of the spread of the disease among animals (precautions as to burying diseased animals, etc.), disinfecting any diseased portion of hides and skins, the use of extraction pans, overalls, and respirators by workmen, and scrupulous attention to personal cleanliness. The presence of any cuts or abrasions on the skin should mean absolute prohibition of contact with hides, skins, etc., and early reporting of any suspicious symptoms is important in view of the value of early treatment. The discovery of a special anti-serum to the poison of anthrax has made a great deal of difference to the outlook in the local skin types of the disease.

Poisonous Fumes and Gases

Poisonous fumes and gases may be responsible for another group of occupational disorders where the portal of entry is the respiratory system. *Carbon monoxide* poisoning is probably the most important of these, because it is so frequently fatal and also because the gas has no smell and early symptoms do not occur. It is found among workers in places where the fumes of burning coke escape, as from coke-ovens and lime-kilns. It is generally present in ordinary coal-gas. The gas gets quickly into the blood and prevents the proper carrying of oxygen to the tissues. Carbon monoxide poisoning is due to carelessness.

Carbon dioxide poisoning may occur among workers in chemical factories or in breweries, or where aerated waters are made. Measures are taken in these trades to prevent the danger; and usually feelings of suffocation occur early enough to enable affected persons to get into the fresh air.

Chlorine and hydrochloric acid fumes may cause trouble among workers in chemical factories, especially where chloride of lime is used to make bleaching powder. The fumes irritate the eyes and throat and may also affect the skin and produce chronic ulceration.

Ammonia and nitrous fumes may produce severe irritation of the lining of the bronchial tubes. The former are given off in a number of trade processes; and the latter in connection, more especially, with the manufacture of explosives.

Sulphuretted hydrogen is highly poisonous. Workers in tar distilleries and in gas works may become affected. In small concentrations the gas produces severe irritation of the eyes, nose, and throat, but even as little as one part per thousand may produce loss of consciousness.

Carbon disulphide is used in vulcanizing in indiarubber works and may produce very serious symptoms. At first headaches, mental dullness, feebleness of muscles, and anaemia may occur, but later severe poisoning to the whole system may set in. In view of this risk there are certain rules laid down for the use of this substance, such as adequate covering of the troughs in which it is used and proper exhaust ventilators. Periodical medical inspection of the workers is also necessary.

Symptoms similar to those caused by carbon disulphide may also result from other vapours from compounds of carbon. Various types of alcohol used in varnishes, and *benzene* used in cleaning, may give rise to headaches, sickness, and giddiness. '*Dope*' *poisoning* occurs among persons using quick-drying varnish (as in painting aeroplane wings), and is due to a carbon compound. Other compounds of carbon, such as the nitrogenous derivations of benzene, cause serious trouble. These are used mostly in connection with explosives, although in aniline dyes the same chemicals may be present. '*T. N. T.*' *poisoning* produces at first the symptoms already generalized for this group; but if the dose is continued there may be serious effects upon the blood, altering the whole chemistry of the oxygen-carrying part, and later upon the liver, which is actually destroyed, so that fatal forms of jaundice may occur. Even if recovery takes place permanent damage may have been done. We are still seeing the results of liver damage caused in this way in young munition workers during the European War (1914–18). Prevention of these disorders lies in careful medical supervision, the use of overalls, head covering, and rubber gloves, with short hours of work and adequate ventilation of the workshops.

Affections of the Skin

Affections of the skin may occur in many trades and, of materials used in various processes already described, there are many which may irritate the skin equally with the lining of the lungs. Anything which irritates the skin of the hands, for example, may produce some degree of inflammation. Thus dermatitis is found among *engineers* and others whose work involves touching oily machines, among workers in *turpentine*, among workers in *salt* (herring curers) and *shale-workers*, and even among workers in what appear to be non-irritant materials, such as those which produce the well-known 'baker's itch' or 'grocer's itch.' Laundrywomen may also suffer from dermatitis, and the hands of many a hard-working housewife are a tribute to the trying nature of her daily occupation. Individual susceptibility may very well play a part in some of these disorders.

Ulceration of the skin caused by *pitch* and by certain forms of *tar* is of importance because of the tendency of such changes in the skin to become cancerous. Adequate provision of washing accommodation (baths and lavatories) is important in prevention; so is the getting rid of as much dust as possible. *Chrome ulcers*, which occur in the skin of the workers in certain chemicals, take a long time to heal. 'Chimney-sweep's cancer' is thought to be brought about by the 'tar' present in the soot of the ordinary coal fire; it occurs after some years of exposure. The prevention of all these skin affections is largely a question of scrupulous personal hygiene and either the substitution of harmless for harmful chemicals or the addition of substances to render harmful chemicals less troublesome. Formaldehyde, for example, is said to lessen the tendency of 'pitch' to produce ulceration.

Suitability of the Worker for the Work

The psychological aspects of industry and occupational disorders have received increasing attention in recent years. While physical disabilities have always provided obvious reasons why certain work could not be done by certain people, psychological disabilities have never been so obvious, because their effects have not been closely studied until recent times. The good employer has always known that contented workpeople mean better work, but modern investigators go deeper than this. It has already been suggested that 'accident-proneness,' for example, may be present in certain individuals who are not suitable for the work in hand.

Perhaps the best-studied example of an occupational disorder due to psychological trouble and the unsuitability of the worker (at the moment) for the work in hand is to be seen in 'telegraphist's cramp.'

For many years this was regarded as some obscure disease of the nervous system. Then, just before the War, 'temperamental' factors were coming to be recognized. More recent investigations have shown that constitutional sufferers from cramp are more susceptible to muscular fatigue, have less control over the muscles employed in telegraphy, and are worse at performing tasks of quick accurate movements than are telegraphists without this susceptibility. Furthermore, the individuals with cramp presented a picture of severe psychological disturbance, conveyed by the terms 'nervous' and 'highly strung.' Workers in other occupations with the same type of disturbance may also 'break down' at their work, but it is not so strikingly obvious as in the very special and exacting work of a telegraphist. It follows that persons with this temperament should not go in for telegraphist's work. Some form of selection along pyschological lines will perhaps abolish this disorder in the future. Writer's cramp may occasionally fall into the same category.

As regards miner's nystagmus it is now suggested that it has its origin in an 'anxiety state' and is analogous to the condition recognized during the European War as 'shell shock.' The arduous nature of the work, the element of danger, and the fear of incapacity are constantly present and induce a mental state which exhibits itself in a bodily disorder which in turn spells rescue from the frightening conditions and brings the chance of adequate compensation. A proper recognition of the mental state (made worse by 'troubles' at home, strikes, wage-disputes, etc.) and a policy which aims at a gradual restoration to full work underground are urged as the method of the future to eradicate this disorder.

These are a few specific (because easily studied) occupational disorders with a psychological basis and dependent in part upon the unsuitability of the work for the worker under existing circumstances. Other forms of 'break-down' occur which are more subtle in their origin. For example, an increased sickness rate in an office (manifesting itself by such vague disorders as indigestion, neuralgia, etc.), or in a school, may sometimes be traced to the bullying methods of a manager or head master. The heads of firms who have called in expert help to investigate this sort of problem have sometimes been displeased with the result! Certain well-balanced individuals can stand up to these varieties of mental injury; but others, less well adjusted in their minds, go under. Vocational selection would help to pick out people likely to crack up under some strain and keep them out of occupations where they would be a misery to themselves and a possible danger to others.

Legislative Measures

Throughout this section stress has been laid upon the preventive aspects of the subject, for, above all disorders, those due to occupational hazards are susceptible of being dealt with by prevention. The famous 'Ordinance of Labourers,' proclaimed in 1349, was the first attempt in this country to regulate the position of master and worker. An Italian named Ramazzini is credited with being the originator of practical industrial hygiene just over three hundred years ago, but England has afforded an example to the whole world in the development of preventive measures in the factories and workshops, and what was once regarded by employers and big business men as unwarrantable interference by the Government is now accepted as a necessary part of all trade processes. Indeed, the prevention of occupational disease was found in many instances to increase the profits in the industry concerned. The principal legislative steps in the development of the present-day system can be summarized as follows:

Towards the end of the eighteenth century appeared the first instance of legislation to protect children in industry in the Chimney Sweeps Act of 1788, and in 1802 came the 'Health and Morals of Apprentices Act,' which is usually held to be the beginning of factory legislation. The early years of the nineteenth century saw the development of many more legislative measures, each advance taking place in the face of great opposition, with the usual appointment of commission after commission to postpone matters. Various acts appeared regulating the employment of children, insisting on times for meals and limiting the hours for work. In 1833 the first factory inspectors were appointed by the State, and in 1842 came the first of a series of enactments relating to work in coal mines. The celebrated 'Ten Hours Act' was passed five years later, but this, like much of the preceding legislation, only applied to young persons under eighteen years of age and to women. Various earlier acts were consolidated and important extensions made in the Factory Act of 1867, and official investigation by medical officers of the State began to bring to light ways in which health might be protected in dangerous trades. A further consolidating Act appeared eleven years later, and the whole of these various enactments were codified in the celebrated Factory and Workshops Act of 1901, the principal Act now in force. Various detailed laws referring to special trades appeared from time to time during this period of development, and by an Act passed in 1916 extensive powers for securing the welfare of factory workers were made available, and this has served to consolidate the advance in conditions of labour made during the War period. Lastly, mention must be made of the Workmen's Compensation Acts dating from 1897, whereby certain scheduled industrial diseases entitle the sufferer to monetary compensation from the employer

PART THREE

STAGES OF HUMAN LIFE

I—THE CHILD

Normal Development

The normal development of a child can be discussed only in terms of averages, as the idea of an average is implicit in the term 'normal.' A normal child is one that borders on the average. The conception of an average is one which many mothers find difficulty in acquiring, and much unnecessary worry results from their failure. The idea may be illustrated by the perhaps more familiar batting average of a cricketer. A man's batting average is said to be thirty runs; this does not imply that he always makes thirty runs; it does not even imply that he has ever made exactly thirty runs. In one game he may make twenty-nine, in another thirty-one. He may be so fortunate as to make forty on one occasion, only to make twenty on his next appearance. So it is with the weight and height and rate of growth of children. An individual may depart considerably from the average without being considered abnormal.

WEIGHT.

The average weight of the normal infant at birth is seven pounds. Even healthy infants weighing less than five pounds require special care, especially in protecting them from heat loss. Infants over ten pounds at birth are unusual, and though their departure from the average is unlikely to affect them adversely after birth, it may give rise to difficulties during delivery. The average baby loses, in the first three days, from 6% to 9% of its body weight. A continued fall in weight after the fourth day must be considered abnormal. This loss in weight of the new-born is due to the fact that the infant excretes, in faeces and urine, more than it assimilates. It does not represent a true loss of the body tissues. After the third day the weight increases and the birth-weight is regained by the tenth day. In some normal infants the birth-weight is not regained until three weeks; but, provided that the gain from the minimum is steady, this slow gain need not be considered abnormal.

Through the first five months the infant should gain weight at the rate of five to six ounces a week. It will thus have doubled its birth-weight at the age of five months. Thereafter the increase is less, and the birth-weight is trebled at the age of one year. The smaller the birth-weight the earlier will the infant double it.

The average seven-pound baby weighs fourteen pounds at five

months and twenty-one pounds at one year. During the second year a gain of a little under seven pounds is usual. During the third year the gain is approximately four pounds. Beyond this age it is not wise to consider weight in relation to age, as the increases are too variable and are better compared with the height of the growing child.

A study of the weight of the infant and growing child is of great importance in assessing its health and progress. An infant should be weighed once a week for the first four months, once a fortnight to the age of eight months, and once every three weeks for the remainder of the first year. During the second year, weighing should be carried out once a month. More frequent weighing than this is, in the case of the normal healthy child, unnecessary, and may be misleading. In cases of illness it may be necessary and valuable.

HEIGHT.

The average length of the new-born infant is between nineteen and twenty inches. During the first year the average growth is from eight to nine inches, during the second year three and a half to four inches, and subsequently about two to three inches a year.

The height varies greatly according to racial and family peculiarities, but is not so markedly affected by disease as is the weight.

THE CIRCUMFERENCE OF THE HEAD.

This averages about thirteen and a half inches at birth, sixteen inches at six months, and seventeen and a half inches at one year. During the second year the circumference increases about one inch, and after that until the age of five years about half an inch a year. The measurement at five years is therefore twenty inches, and after this age the rate of growth diminishes to about half an inch in five years.

THE FONTANELLES.

These are the gaps between the bones of the infant's skull. The vault of the skull is made up of three pairs of bones which at birth are not united, and are to some extent movable in relation to each other. The lines of contact of these bones are called *sutures*, and these are usually filled in by the sixth month, after which movement between the bones of the skull is impossible. Where the sutures meet the fontanelles are found. The small fontanelle at the back of the skull is usually closed by the end of the second month. The larger anterior fontanelle usually measures about an inch in either direction at the end of the first year, and is closed by the age of eighteen months. Its size at birth is very variable.

Through the open anterior fontanelle the pulsations of the blood-

vessels of the brain may be felt and often seen. Such pulsation is normal. Normally the skin over the fontanelle is level with the rest of the scalp. A depressed fontanelle is associated with a debilitated condition, especially accompanying diseases which entail much loss of body fluid, as diarrhoea and vomiting. A bulging fontanelle may be a sign of grave brain disease, and is present when the pressure of the skull's contents is raised, as in hydrocephalus or 'water on the brain,' and in meningitis.

Contrary to widespread belief, there is no danger attached to washing the skin over the 'soft spot' on a baby's head. Firm rubbing with the open hand or flannel may be applied as safely to this part of the scalp as to any other; neglect of this area of the skin of the scalp is a frequent cause of a scurfy and dirty patch, which is common enough among the infants of ill-informed parents to be looked upon as normal, and known as the 'cradle cap.'

TEETH.

The temporary, deciduous, or milk teeth are twenty in number; and usually erupt in the following order:

2 lower central incisors .	6— 9 months
4 upper incisors . .	8—12 ,,
2 lower lateral incisors .	12—15 ,,
4 anterior molars . .	12—15 ,,
4 canines	16—24 ,,
4 posterior molars . .	24—30 ,,

The ages at which the teeth appear are, however, subject to wide variations. Infants are sometimes born with one or more erupted teeth; on the other hand, the non-appearance of the first tooth before the eleventh or twelfth month need not, in the absence of other signs of illness, cause anxiety.

To teething is frequently assigned a variety of minor maladies, from skin rashes and dyspepsia to convulsions and discharging ears, which may occur at this time of life. This fallacy is liable to lead to much well-intentioned neglect of a really sick child.

That teething brings nothing but teeth is certainly not true, and minor disturbances of health are frequent accompaniments of the pain and *malaise* of teething; but it is important to remember that the process of teething does not confer on an infant immunity from other causes of disease, and such possible causes should always be looked for before the trouble is assigned to teething. Teething emphasizes the inherent instability of the infantile organism, but it is certain that in the normal healthy baby it cannot produce of itself such conditions as convulsions, ear discharge, or bronchitis. If such disorders occur

they should, as at other times, be given medical attention. There is no truth in the belief that irregular eruption of the teeth, 'cutting teeth on the cross,' as it is called, is attended by special difficulty. Eruption out of the usual order may, however, be a symptom of rickets.

Medicines and devices for the alleviation of 'teething trouble' are still extensively purchased by a credulous public. The preparations of hare's brain and he-wolf's tooth which were popular for centuries have given place to no less useless teething-powders and the harmful practice of lancing the gums. These things are not helpful, and are to be condemned. A clean bone or ivory ring does no harm, and appears sometimes to afford comfort to a restless child.

Decay in the temporary teeth is probably more often due to causes operating before the birth of the child, such as faulty diet in the expectant mother, than to faulty feeding of the child after birth. The presence of caries in the temporary teeth does not imply that the second teeth will suffer a similar fate, but special attention should be paid to the diet in such cases. The problem of whether carious milk teeth should be extracted is often a difficult one, and is best left to the dentist. The regular brushing of the teeth does not produce healthy teeth, but will keep healthy teeth clean, and thereby maintain their health and their appearance. Healthy teeth are the result, in the first place, of healthy diet. Foods containing Vitamins A and D are believed to be important. The proper development of the jaws by the mastication of hard foods results in properly set teeth; malpositioned teeth are more liable to decay than evenly set teeth. The adherence of starchy or sweet foodstuffs to the teeth between meals favours dental decay, and can be obviated not only by brushing or rinsing after meals, but by finishing the meal with fruit.

VOLUNTARY MOVEMENTS: SITTING, STANDING, WALKING.

The kickings and clutchings of a new-born infant are not truly voluntary. They are known as reflex movements, and occur without the wish or control of the infant. About the fourth month voluntary purposive movement makes its appearance, and the child will grasp at objects. At about the same time the strength of the neck-muscles is sufficient to control the head when the trunk is supported. At about the seventh month the child can sit up, and can stand at the ninth or tenth month. At the age of one year the normal child will walk with support, and will become independent of support three or four months later. None of these accomplishments need to be taught to the child, and the times of their development vary very widely. Thus some children learn to walk without ever mastering the art of crawling.

Gross delay in the development of these various muscular activities may be due to physical causes, such as the child being overweight, or

weak as the result of debilitating disease. Of such diseases rickets is perhaps the most common. Delay may be due to mental retardation of all grades, from mere backwardness, which may be associated with physical debility through underfeeding or chronic ill-health, to the more serious grades of mental deficiency and idiocy. In all such cases medical advice should be sought.

When a child first walks a perfect gait must not be expected. It is not uncommon to see children of eighteen months fitted by enthusiastic shoe-salesmen with more or less expensive and usually unnecessary arch-supports and wedged heels. Some of these appliances actually do harm by resting muscles that need exercise for their proper development. In the matter of a child's gait considerable judgment is sometimes needed to distinguish between the unsteady toddling of a beginner and errors which will become permanent if not corrected early.

SPEECH.

A few simple words such as 'dada' will be correctly spoken by about the age of one year. Thereafter progress is usually rapid, and by the age of two short sentences will have been mastered. Delay in speech, as in standing and walking, may be due to general physical or mental retardation. Mental defect more commonly shows itself by delay in speech than in muscular development. In all cases of delayed speech deafness must be borne in mind as a possible cause.

Lalling or persistence of baby talk beyond the normal age is common, and is almost always the fault of the parents. It occurs, commonly, in one-child families, and is due as a rule to the desire of fond parents to prolong the babyhood of the growing child. To this end they talk only baby talk to the child and in other ways make a pet of him. The lalling child is almost invariably a spoilt child.

Stammering is a very troublesome speech defect and proves so severe a handicap in later years that in most cases expert help should be sought. It is not a defect which is easily outgrown, and special speech and breathing exercises are usually needed for its eradication. The stutterer or stammerer is usually of a nervous, sensitive disposition and acutely aware of his defect. Sympathy is therefore needed, and impatience or thoughtless comment is always harmful. At the outset of treatment attention to the general health and habits and the correction of faulty eyesight are important.

THE EXCRETIONS.

The emptying of the bowel and the bladder are reflex actions in the infant, and are brought under systematic control by the formation of a habit. The training consists in holding out the young infant over a chamber-pot from its earliest days. The hours of 'holding out' should

be regular, after feeds being usually a convenient time. In this way a regular action of the bowels can usually be obtained at a very early age, and soiled napkins become a rarity after the age of three months. Urinary continence is acquired later, but after eighteen months a child should not need a napkin during the day. Failure to acquire control at a normal age is more often the fault of those responsible for the child's training than of the child itself. In its correction punishment plays no part.

In the young infant the bowels normally act two to four times a day, but after the age of two months once or twice a day is usual. A daily evacuation is desirable but, provided the character of stools is normal and constipation (hard motions) not present, a child may miss two or three days without apparent harm. In such a case the administration of laxatives is not needed; nor is anxiety justified. If felt, it should not be communicated to the child. The daily habit should, however, be re-established by persuasion and firm handling. Local stimulation with soap-sticks and suppositories is not desirable.

The weekly 'cleansing' of the bowel widely advocated by advertisers of proprietary medicines is a pernicious but widely practised rite.

SLEEP.

During the first six to eight months of life a healthy infant will sleep almost continuously between feeds. During the later months of the first year the increasing power to control his limbs and do things will result in the child's wanting to exercise and play; and an hour should be set apart for this. A child should at all times sleep in fresh air and, if possible, in the open air; he should be shaded from the glare of direct sunlight. The rapidity with which children fall asleep after being put to bed, even in favourable surroundings, varies greatly in different individuals. Once the child has been put to bed he should be left alone and not rocked or petted or sung to. Every child should have a bed to himself. The necessity for sharing beds is the cause of much wakefulness and consequent ill-health among children of the poorer classes. Up to the age of eight children should have a minimum of twelve hours' sleep at night. They should be abed by seven o'clock.

The Feeding of the Normal Infant

The feeding of the normal infant is a subject which has only of recent years engaged the attention of the medical profession, and even in these days it is not uncommon to find members of that profession who have but the haziest ideas on this important subject. It is a part of the management of infancy which is still largely left to the mother or nurse, and it therefore behoves any one in such a position to master the simple facts in connection therewith.

The object of this section is rather to outline the easily understood principles upon which modern teaching with regard to the dieting of infants and children is founded than to set out any hidebound rules of feeding; to give a review of available methods rather than to advocate one rigid system.

THE NATURE OF THE FOOD: BREAST-FEEDING.

The consensus of informed opinion, based upon the results of innumerable observations and supported by reliable statistics, is that *normal breast-milk is the best food for the normal infant.* The change in thought on these matters has been so profound of recent years that to some the statement of such an axiom may seem superfluous—the reader may well say, 'But everybody knows that.' The fact remains that it is only in the last twenty years that this truth has been widely recognized. Moreover there are two factors at work which, unless counteracted, may well result in a widespread failure to accept this axiom. The first of these is the present economic depression which drives women who would otherwise be suckling their infants back to their offices and shops in order to help in the financial support of their homes.

The second factor which may result in a falling-off of the numbers of breast-fed infants is the understanding of better methods whereby the dangers of artificial feeding may be minimized. The death-rate among artificially-fed infants one hundred and fifty years ago was estimated at over 66%.

A knowledge of germs and their relation to disease, combined with a more securely acquired knowledge of the nutritional requirements and digestive abilities of young infants, has resulted in a great improvement in feeding methods. An infant for any reason deprived of human milk has, in these days, *almost* as good a chance of healthy survival as its more fortunate breast-fed brethren. It would, however, be a pity if such an advance in preventive medicine were made an excuse for the routine employment of what is, at best, a makeshift. Where there is normal breast-milk, a normal baby who is artificially fed is only getting second-best food. This fact with regard to breast-feeding has been stated as an axiom based on experience and universally accepted by those who know. It may, however, be of interest briefly to review certain other considerations which can lead us to the same conclusion.

ADVANTAGES OF BREAST-FEEDING.

The first of these is that in breast-milk the infant is getting a fluid adapted by Nature for his needs, containing adequate proportions of the various constituents which constitute a complete food, in an easily digestible form.

No other food, no matter how modified, cooked, diluted, or reconstructed, can exactly reproduce breast-milk.

Secondly, breast-feeding involves far less trouble than does any system of artificial feeding. This consideration will, of course, make no appeal to those who enjoy the doubtful advantage of being able to hand over to others the responsibility of managing their infants' dietary.

There is evidence that breast-milk, and especially the milk called *colostrum*, which flows from the breast in the first few days after the baby is born, contains many *anti-bodies*, that is to say, substances which have the power of killing germs, and by their presence protect the infant from infectious diseases; no such substances are found in artificial foods.

Again, the infant derives benefit from the act of sucking at the breast. The act of sucking appears to aid the natural development of the muscles used and, as a result, of the bones to which these muscles are attached. These are the bones of the jaws and palate, and on their proper development the growth of the teeth and of the air passages through the nose depends. By the use of suitable teats on bottles and a careful technique this particular disadvantage of artificial feeding may be minimized, but it is doubtful whether the exercise involved in sucking the breast can ever be accurately aped.

Finally, the mental and physical benefit which the normal mother derives from suckling her infant cannot be overlooked. The mental aspect is a question for the individual. Some mothers find what satisfaction they get inadequate recompense for the restriction of their activities which regular breast-feeding inevitably involves. Some mothers are deceived by the appearance of their milk, which, having normally a thin and more watery appearance than cow's milk, they conclude is inadequate to nourish their baby.

The physical benefits accruing to the normal mother by suckling are second only to those accruing to the infant itself. In the early weeks after the birth of the baby the act of suckling at the breast helps to promote the normal processes of shrinking, or involution, which the womb has to undergo. Not infrequently a delay in this shrinking is accompanied by low backache and blood-stained discharges, and the occurrence of such symptoms has often led to weaning the baby, when the continuance of suckling would have favoured their cure.

From the foregoing it will be clear that in the vast majority of cases breast-feeding is the ideal method of infant feeding from every point of view, and no effort should be spared by mother, nurse, or doctor to see that it is achieved. Where there is insufficient breast-milk to meet the whole needs of the infant, artificial food may have to be given in addition—complementary feeding. This, in many cases, is only a temporary measure, the supply of breast-milk later increasing

sufficiently to warrant the discontinuance of the bottle-feed. In any case what breast-milk there is should be given to the infant.

CONTRA-INDICATIONS TO BREAST-FEEDING.

Certain circumstances justify the abandonment of breast-feeding, but they are happily rare. The presence of active tuberculosis of the lungs in the mother necessitates immediate weaning. This is due to the fact that the disease is extremely infectious and the new-born baby extremely susceptible. The infection may possibly be conveyed by the milk, but is usually conveyed by contact with the mother, and the presence of this disease is an indication not only for weaning, but for complete separation of the mother and infant, if the latter's health is not to be gravely jeopardized.

Certain cases of severe heart disease necessitate artificial feeding, the slight extra strain occasioned by suckling being too much for a gravely damaged heart. This is not to say that a woman who occasionally experiences palpitation on exertion should immediately abandon breast-feeding. Many sufferers from minor degrees of heart trouble successfully nurse their babies, and indeed acquire actual benefit from the slight restriction of their usual activities which such a course entails.

Other chronic diseases, such as diabetes and kidney disease, may necessitate the abandonment of breast-feeding.

Epilepsy, if the fits have not been controlled by drugs, makes breast feeding, or indeed the care of a baby at all, unsafe. If the epileptic mother has to take large doses of such drugs as the bromides in order to prevent the fits, these drugs may be excreted in the milk in sufficient quantities to affect the infant; weaning is then the only possible course.

Local conditions of the breast itself, such as cracked nipples or breast-abscess, may necessitate a temporary interruption of feeding from the affected breast. Ordinarily they do not need complete weaning for their cure.

The return of menstruation is sometimes accompanied by an increase in the flow of milk which results in a temporary upset of the infant's digestion. This should never be a cause of weaning. There seems to be a widespread belief that at the menstrual periods the mother's milk is definitely harmful to the baby. This is not so. In most cases there is no change in the flow of milk; if the quantity is increased, the fault can easily be remedied by curtailing the feeds for a day or two at the time of the menstrual period.

The occurrence of a second pregnancy during the period of lactation is happily not as common an event in these days of birth-control as it was formerly. When it is certain that pregnancy has occurred, and not before, the baby should be slowly weaned; there is no need for a *sudden* cessation of breast-feeding.

In this connection it may be well to dispel a popular error which has had wide currency. Lactation has no ascertainable contraceptive effect. Many mothers have deluded themselves with the belief that they could not become pregnant as long as they were suckling their infant. In this belief breast-feeding has in the past been continued beyond the twelfth month, with bad effects on the infant.

A healthy woman is fulfilling a natural function in suckling her infant; if symptoms of ill-health occur during the exercise of this natural function it is not reasonable to attribute such symptoms to the act of suckling; the wise will consult their doctor with a view to finding out the true cause, which can often be easily corrected. Suckling does not of itself cause lassitude or headaches or pains or sleeplessness; therefore weaning the baby is unlikely to cure such symptoms. Some other cause should be sought.

LACTATION.

Lactation, or the pouring out of milk by the mammary gland, is sequent to the termination of pregnancy. From the early days of pregnancy changes take place in the breasts, which changes consist in a building up of the tissues of these glands to enable them to fulfil their later duties. In the final months of pregnancy it is often possible to squeeze small drops of fluid from the enlarging breasts; this fluid is not, however, milk. When pregnancy is ended with the delivery of the child certain chemical changes take place in the body, which result in an activation of the already built-up glands of the breast; the flow of milk is thus started. At first the secretion of the breasts differs somewhat from ordinary breast-milk, and is known as 'colostrum.' There is reason to suppose that this early flow from the breasts is particularly suited to the needs of the new-born baby, and of considerable value to it. Thus it is a concentrated, easily digested food, adapted to the needs of a newly-working digestive apparatus. It is also believed to contain *anti-bodies*, which, as already explained, help the infant to resist infections by germs, which it is now meeting for the first time.

The quality of the milk gradually changes, during the first weeks of lactation, from this early colostrum to the ordinary breast-milk.

The mode of onset of lactation is very variable. At the one extreme are found those cases in which the breasts fill gradually with milk and, apart from a slight feeling of fullness, the mother experiences no discomfort; the flow is well established by the third or fourth day, and the baby obtains a plentiful supply without difficulty. At the other extreme the filling of the breasts may be fairly sudden, and the accumulation of milk in the breasts may cause swelling, hardness, and great tenderness. This may occur from the second day onwards, but

seldom lasts more than twenty-four hours. As soon as the flow is established the unpleasant symptoms subside; the hardness and 'knottiness' of the breasts disappear, sometimes rather unevenly, outlying areas of the breast tissue remaining firm and tender for a day or two. Between these two extremes there are any number of intermediate variations; they must all be looked upon as normal and need not give cause for anxiety.

THE NATURE OF BREAST-MILK.

Food-stuffs, as is more fully explained in other sections of this book, are divided by the chemist into three main groups, known as Proteins, Carbohydrates, and Fats. The presence of all these three substances is essential in a diet if health is to be maintained. All are present in milk.

Of the three classes of food-stuffs, Carbohydrates, Proteins, and Fats, the first is the most easily assimilated and the most readily used as fuel. It is not surprising, therefore, to find it preponderating in breast-milk. Human milk contains 7% of carbohydrate, all in the form of milk sugar or lactose.

If given in excess of the immediate needs of the body for fuel carbohydrates are converted into fats, and stored as such. It is in this way that a child, or adult, fed on excess of starch or sugar will gain weight. This extra weight does not consist of muscle or bone, but of excess fat, which gives the body the characteristic pale, flabby appearance. This distinction is not sufficiently well appreciated by the public, and accounts for the success which many patent body-foods enjoy. The baby's weight is seen to be increasing rapidly, and this is interpreted as healthy growth, whereas it is merely an increased storage of redundant carbohydrate in the form of useless and eventually burdensome fat.

The protein content of human milk is 1·5%, and consists of two types of protein, one of which forms curds in the stomach, and is known as *casein*, whilst the other, which does not coagulate into curds in the stomach, is known as *albumen*. The latter preponderates considerably in human milk.

The fat content of human milk is 3·5%. This figure represents an average, for actually the fat content of human milk varies considerably in different individuals. There is very little evidence that the fat content of any one woman's milk can be much altered by changes in her diet.

The chemical composition of an average sample of human milk may thus be summarized:

SUGAR (lactose)	7 %
FAT	3·5%
PROTEIN	1·5%

In addition to these three classes of food constituents, human milk also contains vitamins, or accessory food substances. The presence of these substances is essential to healthy growth, the absence of any one of them over a period of time resulting in a characteristic disease. Examples of such diseases are afforded by rickets, due to the absence or insufficiency of Vitamin D from the diet; and scurvy, due to the absence of Vitamin C. The presence of the necessary vitamins in breast-milk depends upon the mother's diet and hygiene; if the mother's diet contains a sufficiency of the vitamins they are secreted in the milk. Thus the milk of a mother who includes in her diet a daily ration of fresh milk, butter, eggs, and animal fats, will contain sufficient Vitamin D to protect her infant from rickets. On the other hand, rickets is not uncommonly seen in the infants of poor mothers who substitute margarine for butter, skimmed condensed milk for whole fresh milk, and to whom eggs and meat are rare luxuries.

FREQUENCY OF FEEDING.

The old practice of feeding at short intervals has now happily fallen into disrepute, and emphasis has rightly been laid on the importance of a regular rhythm in the feedings. These may take place either at three-hourly or at four-hourly intervals throughout the day, with an eight-hour rest for both mother and infant at night. This regularity of feeding is of obvious advantage to the mother; the infant may at first appear to resent such a regime, and it not infrequently happens that an inexperienced mother will feed her infant at all hours of the day and night in an effort to prevent crying. That the effort is usually fruitless need hardly be said; for the child experiences all the internal discomfort which an adult would undergo if he indulged in square meals at short and irregular intervals throughout the day. In fact, the infant is potentially a creature of habit, or, in modern scientific phrase, of conditioned reflexes. If a regular regime of feeding is imposed and strictly followed out, he very soon adapts himself to this as to other factors in his new environment.

Whether this regime should be three-hourly or four-hourly feeding matters little to the average healthy baby. Both have their advantages. The four-hourly regime, feeding at say 6 a.m., 10 a.m., 2 p.m., 6 p.m., and 10 p.m., gives the mother leisure for other duties or for relaxation. Most normal babies are able in five feedings to take sufficient nourishment for their needs, and the four-hour interval ensures that the stomach is empty of one meal before the next is started, and that the digestive glands are prepared for their work.

The three-hourly regime, feeding at 6 a.m., 9 a.m., 12 noon, 3 p.m., 6 p.m., and 10 p.m., is necessary for small infants with small stomachs,

or weakly infants who do not suck strongly. It is also necessary where the supply of breast-milk is small.

The maintenance of lactation is dependent upon two factors, the stimulus of sucking at the breast, and the emptying of the breast. It will be clear, therefore, that on the three-hourly regime the breast is sucked six times, whereas on the four-hourly regime only five feeds are given. On the other hand, the child is more likely to empty the breast four hours after its last feed, than three hours after.

The eight-hour rest at night is of the utmost importance to both mother and child, and need never be interrupted with a feed in the case of a normal infant. With very small premature babies night-feeding is necessary.

It is usual to give both breasts at each feeding; in this way only the first breast given will be completely emptied, and it is therefore important that the breast which is given first at one feeding should be given second at the next. Usually ten minutes at each breast suffices; but circumstances, such as have already been mentioned, may arise which call for modification of this routine. No hard and fast rules can be laid down, but as stated already, the average baby will thrive on five four-hourly feedings of ten minutes on each breast, with an eight-hour rest at night, and such a routine gives the mother the maximum of comfort and leisure. With healthy babies of average weight such a regime can be embarked upon from the second day of life. During the first twenty-four hours, both mother and infant require rest, and six-hourly feeding during this period is the rule.

QUANTITY OF FEEDS.

Normally it is not of any great importance or interest to the mother or nurse to know what quantity of breast-milk the infant is taking, and actually the amounts taken by a healthy infant are subject to very wide variations. If the infant is contented and gaining weight satisfactorily, and if there are no signs of digestive upset as judged by the nature of the stools, it may safely be assumed that the quantity of breast-milk is correct. Indeed, it is wise as well as safe to assume so, for the alternative is to 'test-weigh' the infant; and not only is this a somewhat laborious process, but its results, if not correctly interpreted, are often misleading, and a frequent cause of unnecessary worry on the part of an over-anxious mother, with resulting diminution in her milk-yield. If the infant is obviously thriving, test-weighing is definitely contra-indicated. Its chief application is in those cases where there are symptoms pointing to an insufficiency of breast-milk. The technique of test-weighing, and the interpretation of the results, will be described in a later paragraph. It will suffice for our present purpose to say that the baby is weighed accurately before and after feeding, the difference in the weights

being the weight of milk sucked at that feed. This process is repeated at every feed, and the total intake of breast-milk during the day is thus arrived at.

By making such investigations concerning many thousands of healthy infants of all weights and ages an average figure for the nutritional needs of the normal infant has been arrived at. This is found to be about two and a half ounces of breast-milk during the day for every pound of the baby's weight. That is to say, a ten-pound baby requires about twenty-five ($2\frac{1}{2} \times 10$) ounces of breast-milk during the day. A fifteen-pound baby would require thirty-seven and a half ($2\frac{1}{2} \times 15$) ounces of breast-milk in the day. It must be remembered that this is only a very rough guide. It is an average figure, and many healthy infants do in fact gain weight normally and keep perfectly fit on very much less nourishment than this average figure indicates.

As the infant grows he is less liable to suffer loss of heat through his skin, and it is found that his food requirements are correspondingly less, so that, at the age of six months the normal infant requires in food value little more than two ounces of breast-milk per pound of his body-weight.

At about this age of six months, however, a new factor comes in. The infant is now beginning to make more vigorous movements, and to take an appreciable amount of exercise, so that additional rations are needed as fuel to provide for this increased output of energy. The infant's food requirements begin to rise again, so that at nine months of age he once more needs an amount of food corresponding to about two and a half ounces of breast-milk per pound of body-weight. It is not usual for all this energy to be provided by breast-milk, other foods having been introduced by the time the child is nine months old. It is clear, therefore, that at this age and onwards some other unit of food value than a given volume of breast-milk is required to assess nutritional requirements. This brings us to the *calorie*, which is a unit of heat, and therefore of energy; it expresses the fuel value or energy-producing value of any given food. Thus one ounce of breast-milk is found to have an energy-producing value of twenty calories. We may therefore recapitulate the statement of the infant's energy requirements as follows; at birth an infant requires fifty calories per pound of body-weight—a seven-pound baby requires three hundred and fifty calories; at six months the energy requirement has fallen to a little over forty calories per pound of body-weight, and rises to fifty calories again at the age of nine months.

The importance of these facts becomes clear when attempts are made to design an artificial diet for the young infant. If the calorie-values of the various ingredients are known there is no difficulty in ascertaining the total food-value of the diet. Certain widely used systems of infant

feeding are based on such calculations, and their principles cannot be well understood without some conception of the meaning of the fuel-value of foods and of the calorie, which is a measure of this fuel value, as the shilling is a measure of monetary value.

THE TECHNIQUE OF BREAST-FEEDING.

Just as one of the most important factors in successful breast-feeding is the mental comfort and freedom from worry of the mother, so in the successful management of the individual feed her bodily comfort and that of her infant are first considerations.

During the first ten days the mother will have to feed her baby while lying in bed, and she will therefore need the assistance of a nurse or attendant. The mother should lie on her side supported in a comfortable position by pillows. The nipple should then be gently cleaned with water and a soft linen rag or piece of gauze. The baby is then brought to the mother and lies parallel to her in the bed, in such a position that the nipple falls into the infant's mouth. The rest of the breast is kept clear of the infant's nose by the mother's upper or free hand, the first and second fingers being placed one on either side of the areola, or pigmented area of skin surrounding the nipple. When the infant has emptied the first breast he should be held up over the shoulder of the attendant in order to give him an opportunity to bring up any wind he may have swallowed, while the mother arranges herself in comfort on the other side ready to complete the feeding with the second breast. At the end of the feeding the infant is again held up, and then returned to his cot. This second holding up may well be done by the mother, but prolonged 'dandling' or rocking to and fro is not only liable to make the infant vomit part of the feed, but inculcates bad habits, so that the child begins to expect such 'nursing' after the feeding, and will not settle down to the sleep which should naturally follow feeding. At the end of feeding the nipples should again be cleaned and dried, and covered with clean linen, so as to prevent contact with the clothing.

An equally definite routine should be followed when the mother is up and about. Quiet and comfort are essential. It is asking for trouble to attempt to breast-feed an infant just anywhere. A low chair should be used, and the baby should rest on the mother's lap supported by one arm. The knee on the same side as the breast to be used may be raised by placing the foot on a stool. A glass of water may be placed on a table within reach and drunk by the mother during the feeding. The object of embodying this in the routine is to ensure that the mother has an adequate daily fluid intake. There is no particular virtue in taking this extra fluid at the times of feeding, but if not done at this time it is easily forgotten, and a sufficient intake of water is an important factor in successful lactation. The room in which the feeding

takes place should be quiet, and the mother should be free from disturbance, so that she can give her whole attention to the infant.

The mother should sit slightly forward so that the nipple and surrounding areola may be easily directed by the free hand into the infant's mouth. In all other respects, the technique of feeding is similar to that followed during the early days while the mother was still in bed.

MOTHER'S DIET DURING LACTATION.

Little need be said on this matter, as it is now generally agreed that a nursing mother should take the food, both quantity and kind, that ordinarily suits her best. From time immemorial the virtues of various foods, drinks, and medicines have been extolled for increasing the supply of breast-milk. They are known as galactagogues, but it is doubtful if such things, in fact, exist. Avicenna, an Arabian physician of the eleventh century A.D., recommended a decoction of earthworms in barley-water or the heads of flying-fish steeped in dill-water. In the sixteenth century faith was placed in a preparation of dried cow's tongue or neat's tongue, poached eggs, and a great variety of herbs. In more recent days the value of oatmeal stout as a galactagogue has been proclaimed. The truth is that all these alleged remedies for a deficient milk-supply act by suggestion; the diminution in milk output being most commonly due to the mother's worrying.

Apart from fluids, then, a nursing mother should take what best suits her palate and her digestion. It may be borne in mind, however, that the supply of vitamins in the breast-milk is dependent on the mother's intake of these substances.

The taking of alcohol-containing drinks during lactation is a subject upon which strong views have been expressed. The truth is that, taken in moderation, wines and beers do not affect either the quality or the quantity of the breast-milk. A woman who is in the habit of taking a glass of wine or beer with her meals may find her digestion or her peace of mind impaired by the sudden discontinuance of this aid. She may without harm continue in her habit. On the other hand if a woman is not accustomed to take alcoholic drink she should in no circumstances be persuaded to take it during lactation.

The regular action of the mother's bowels during lactation is of importance. This regularity is sometimes disturbed owing to the loss of fluid through the secreting breasts, and may usually be restored by a slight increase in the fluid intake. If, on a reasonable diet and sufficient fluid intake, constipation is still troublesome, mild laxatives may be used. Strong purgatives are best avoided.

DIFFICULTIES OF BREAST-FEEDING.

Difficulties in the course of breast-feeding may be due either to the mother or to the child.

Under the former heading may be placed complications arising from too liberal a supply of milk or from too little milk; natural abnormalities of the breast; engorged and painful breasts; cracked and sore nipples; and breast abscess.

OVERFEEDING ON THE BREAST.

Is perhaps the commonest cause of disturbance in the breast-fed infant. Its commonness is largely due to the fact that it is rarely suspected by the mother in its early stages. At the onset of overfeeding the infant not only continues to gain weight, but may for a while gain at an increasing rate. This should be the danger signal, but it is one which is seldom heeded even by quite intelligent mothers. Many appear to think that their infant can in this way build up a reserve of weight 'against a rainy day,' and are only disillusioned when the continued overfeeding results in the inevitable dyspepsia with an accompanying loss in weight, often difficult to check. An early symptom of overfeeding is crying shortly after the feeding, which is frequently misinterpreted as a cry of hunger. Actually it is the cry of discomfort occasioned by the overcharged stomach. This overfilling of the stomach may result in vomiting, and the vomiting may serve to protect the infant from the more severe forms of dyspepsia which result when the excessive feeds are allowed to pass through and overtax the rest of the intestine. At the same time the vomiting may be excessive, with the net result that the infant is not receiving enough food for his body's needs.

Crying after feeds and vomiting are early symptoms of overfeeding. If, in the absence of, or in spite of, this protective vomiting, excessive food is passed on from the stomach to the bowel, diarrhoea commonly results. The stools lose their normal consistency and yellow colour, and become green and watery, and are accompanied by the passage of slime or mucus, due to the irritation of the mucus-secreting glands of the bowel. The passage of food through the bowel is normally accompanied by the absorption of water, so that by the time the food residue reaches the lower bowel it has become less fluid, and assumes the characteristic pasty consistency of the normal stools. When the bowel is irritated, whether by excess of food or by unsuitable food, it acts for its own protection in the most natural way, by trying to get rid of the cause of the irritation. In this way the food is hurried along the bowel, and there is no time for the normal absorption of water to take place. The characteristic watery, frequent stools of overfeeding result. These stools may also contain portions of undigested food in the form of curds. If untreated, overfeeding may give rise to very severe wasting disease. In its milder forms it is, as has been said, probably the commonest form of digestive upset to which the breast-fed infant is liable. The treatment of the condition in its early stages is simple, and consists in curtailing the length of the breast-feeds. It is a constant

source of surprise to mothers to find in how short a time a healthy baby may extract adequate nourishment from some breasts. Babies have been known to suck as much as seven ounces of breast-milk in three minutes. If mere shortening of the times at the breast is not sufficient it may be advisable in such cases to resort to feeding on alternate breasts, only one breast being given at each feeding. It is frequently useful to give boiled water immediately before the breast-feed in order to slake the infant's thirst, and so reduce the rate of sucking. Up to two or three tablespoonfuls of boiled water may be so given, and is best administered by spoon; if the spoon is refused a bottle may be used. When persistent overfeeding has resulted in severe diarrhoea and loss of weight a doctor's advice should be sought. It will usually be necessary to rest the bowel completely by giving water only for twelve to twenty-four hours; and the breast feeds, when resumed, will have to be very short at first, in order not to overtax the irritated bowel. However severe such a digestive upset may be, it is never to be taken as an indication for weaning. Indeed, the more severe the upset the greater will be the recovering child's need for the most easily digested of all infant foods, namely, breast-milk.

UNDERFEEDING ON THE BREAST.

This condition is not nearly so common as the foregoing, overfeeding, and is not so serious in its consequences. Nevertheless, a fear of underfeeding her baby is, perhaps, the commonest cause of anxiety in the nursing mother. Conversely, the commonest cause of a diminution in the supply of breast-milk is anxiety on the mother's part.

Happily it is usually only a temporary difficulty, and in cases where the mother can be persuaded of this the milk is soon found to increase in quantity.

There are, however, cases in which the supply of breast-milk, for longer or shorter periods, sometimes throughout lactation, is insufficient to supply the nutritional needs of the infant. In such circumstances the infant shows signs of hunger, that is to say, he cries, usually before the next feed is due. Sometimes the crying occurs immediately after the feeding, but more usually crying is delayed. It is impossible to describe the cry of a hungry child, but it differs markedly from the cry of discomfort which follows the feed in the case of the overfed child.

A valuable guide is afforded by the weight chart. An underfed infant will not gain sufficient weight; a word of warning is here needed as an overfed child may, as has already been pointed out, lose weight to an equal extent. Still, in conjunction with other symptoms, a progressive loss in weight may be taken as evidence of underfeeding. The stools of an underfed baby depend to some extent upon the degree of the fault. They may be normal, but where underfeeding is consider-

able the typical 'hunger stools' appear. These consist of small, very dark brown or green stools, usually solid or semi-solid in consistency, accompanied by mucus, and passed four or five times a day.

The underfed baby will, until underfeeding has been so long continued that general constitutional weakness has resulted, usually suck voraciously at the breast. The treatment therefore consists primarily in increasing the supply of breast-milk.

INCREASING THE SUPPLY OF BREAST-MILK.

The most important measure for promoting this end consists in allowing the infant to stimulate and to empty the breast at regular intervals. If the baby is on the usual four-hourly feeds, the routine may be changed to three-hourly feeds, and both breasts should be used at each feed. After the feeding the breast should be 'stripped,' that is to say, emptied manually. This is achieved by grasping the breast firmly between the thumb and forefinger and exerting steady, but not painful, pressure towards the nipple in a 'milking' movement. The ducts containing the milk are in this way emptied mechanically. This is only necessary in those cases in which the breast has not been emptied by the infant's sucking. If the breasts are tender the emptying may be achieved, but usually not so completely, by the use of the breast-pump. Massage is of great value. This is best carried out by a nurse, but may be done by the mother herself. Twice a day the breast may be rubbed by hand, the rubbing being always towards the nipple. Alternate hot and cold sponging is also sometimes helpful. Two basins are needed, one containing hot and the other cold water, two sponges are used, and the breasts, supported by the hand, are first sponged with the hot and then with the cold water. This is followed by vigorous rubbing with a rough towel.

Chronic underfeeding is as undesirable as chronic overfeeding, and, if persistent, must be met by *complementary* feeding, that is to say, the giving of an artificial feed *after* the breast-feed. The details of making-up the artificial feed will be discussed more fully in the section dealing with that subject. Certain aspects, however, may here be usefully considered.

THE TEST-FEED.

The only accurate way of determining the quantity of extra nourishment to be given to an infant who is being underfed on the breast is to carry out a series of test-feeds. For this purpose an accurate pair of scales furnished with a set of weights is essential. Spring balances are never to be relied upon for this purpose. The baby, dressed in its ordinary clothes, is weighed to the nearest quarter of an ounce. It is then given a full breast-feed, every effort being made to induce the

infant to empty the breasts. After the feed the child is again weighed, no change being made in the clothes; if a napkin has been soiled during the feed this must not be changed until after the second weighing. In this way the weight of milk obtained from the breasts during the feed is ascertained to the nearest quarter of an ounce. If the infant has left any milk in the breasts this should be expressed by hand, and measured in a medicine glass. The process is repeated at every feed throughout the day. It is found that in the case of normal fully breast-fed infants there are very considerable variations in the amount of milk sucked at each feed; the biggest feed is usually the first feed in the morning. On this account an accurate result can only be obtained by carrying out test-feeds throughout the day. In practice, however, and especially where the mother cannot test-weigh at home, and the clinic or welfare centre has to carry out the work, two test-feeds are done, and the total daily output of milk calculated from these two observations.

In this way an indication is obtained of the amount of artificial complementary feed that is needed to ensure that the infant gets sufficient nourishment.

COMPLEMENTARY FEEDING.

The complementary feed is an artificial feed given directly after the breast-feed. In most cases it is to be regarded as a temporary measure which will be discontinued when the supply of breast-milk is again sufficient. This attitude of mind towards the complementary feed is of importance as it serves to remind us that the true treatment of under-feeding on the breast is to increase the breast-milk supply. It is for this reason that the breast is always given before the complementary feed in order that the hungry baby may stimulate the breast by vigorous sucking and by emptying it.

The quantity of the complementary feed is of importance, and is based, as already explained, upon the results of test-feeds. Even so, in the case of a normal healthy baby it is unwise to make up the full nutritional requirements with artificial feeds; it is usually better to keep the quantity of extra food low so as to maintain a healthy appetite for the breast. It is not uncommon to find babies who have been given complementary feeds weaning themselves from the breast. This is often due to the extra feeds being too large, so that the baby is not sufficiently hungry when next put to the breast; as a result the sucking is feeble and insufficient to stimulate the breast to increase its supply. Test-feeds carried out at this juncture may show an actual diminution in the supply of breast-milk, and this is made a reason for a further increase in the artificial feeds. In this way a vicious circle is set up which ends only when the child is fully artificially fed.

Another factor which contributes to this state of affairs is the com-

parative ease with which an infant sucks milk from a bottle. It has been shown that more exertion is needed to get milk from a breast than from a bottle. The lazy infant will frequently learn to prefer the bottle-feed to the breast-feed, and refuse to suck at the breast. This can usually be prevented by the use on the bottle of a hard-drawing teat, that is to say, a teat with a very small hole, through which the milk will only drop at about the rate of one drop every four or five seconds.

A further difficulty may arise through the artificial feed being sweeter than the breast-milk, and the infant preferring it on this account. This is especially true where sweetened condensed milks are used for complementary feeding, and on this score they are quite unsuitable. It is not proposed to enter into the details of the constitution of artificial feeds, but it will suffice to say that where the artificial feed is being used as a complementary feed the proportion of sugar should be kept lower than would be the case if the feeding were entirely artificial. It is in complementary feeding that such sugars as lactose or dextro-maltose have their chief use, as they are less sweet than cane sugar, while being at the same time no less nutritious.

It may not be necessary to give the complementary feeds after every breast-feeding throughout the day. In these circumstances the most convenient practice is to give the bottle after the last two or three breast-feedings. This system usually works well and ensures a sufficient quantity at the last feed to enable the child to sleep through the eight-hour night interval. It is not often necessary to give a complementary feed after the first morning feeding, as test-weighing may show that this is the largest of all the feeds and sufficient for the infant's requirements. In cases of difficulty test-weighings are carried out throughout the day, and the complementary feed given after the smaller feeds. Many infants are found to suck sufficient for their needs at the first and last feeds. In such a case to complement the last feed would over-fill the baby, and make for an uncomfortable night. It is better in such an event to give the complementary feed after one of the earlier breast-feedings.

SUPPLEMENTARY FEEDING.

This implies the giving of an artificial feed *instead* of a breast-feed. As a routine method of part breast-feeding, it is to be condemned; its practice almost invariably resulting in a diminution in the supply of breast-milk and rapid weaning. This is due to the lack of regular stimulation of the breast which supplementary feeding involves; it is in fact the method by which weaning is normally accomplished at the end of lactation. Unfortunately the practice is still widespread among mothers who imagine that they are thereby increasing their breast-milk supply. To rest the breast in the hope that it will thereby become more

full of milk for the next feed is quite fallacious. Supplementary feeding, however, is legitimate in those cases where it is economically impossible for a mother to give the breast at every feed. Thus a mother who was anxious to breast-feed her baby but was engaged in a theatrical production which involved two matinée performances each week, successfully fed the baby while substituting two supplementary feeds per week. In this case the hours of feeding were 7 a.m., 11 a.m., 3 p.m., 7 p.m., and 11 p.m., and on two days a week a supplementary feed was given at 3 p.m. Though not to be regarded as an ideal method, supplementary feeding in such a case is a necessity, the alternative being complete weaning of the infant. In the later months of lactation an occasional supplementary feed does not the slightest harm, and permits the mother to enjoy social activities which would otherwise be impossible.

DIFFICULTIES DUE TO ABNORMALITY OF THE BREASTS.

Breasts vary very much in both size and shape, and it is impossible from its appearance to say whether any given breast will be satisfactory in its milk-producing properties. The breast is made up of glandular tissue, which produces the milk, and supporting tissue. A large breast may consist largely of supporting tissue, and therefore produce a poor secretion; on the other hand a small, flat breast is often found to yield a large supply of milk, being composed almost entirely of glandular secreting tissue, and deficient only in the less important supporting structures.

A large pendulous breast may cause difficulty in suckling owing to its obstructing the infant's nose, and thus preventing breathing during the feed. In such a case special care must be taken by the mother to hold the breast away from the infant's face with her disengaged hand.

Depressed and Small Flattened Nipples sometimes give rise to real difficulty in nursing as the baby cannot get a firm grip of them. The shape of such nipples can be greatly improved during the later months of pregnancy by drawing them out gently with the finger and thumb every day, and the same treatment should be applied after the birth of the child. Every effort should be made in such cases to get the infant to suck, as this is the most effective cure of the condition. The infant's efforts may be aided after the feed by judicious use of the breast-pump. It is essential that the nipple should be drawn out sufficiently for the infant to grasp it before the breasts fill with milk, as even a slight degree of engorgement of the breast will make the flattened nipple still more inaccessible to the infant's mouth, and the natural relief of the engorgement, namely, the infant's sucking, will then not be available.

Engorgement of the Breast may be general or local; that is to say, the whole breast may be involved or only one or two lobules of the gland may be affected. When the whole breast is tense and painful the cause

is usually a rapid production of milk with inefficient sucking on the part of the infant. This poor sucking may be due to a weakly infant or, as has been said, to malformed nipples. In either case the use of a breast-pump is indicated to relieve the tension in the engorged organ.

Where only one or two lobules are affected these stand out as hard, knotty lumps, usually in the outlying positions of the gland and most commonly in the lower and outer quadrant. The condition is usually due to blockage of one of the milk ducts, and gives rise to considerable pain and tenderness in the affected region. The blockage can often be relieved by sucking, either by the infant or by the pump. The pain is greatly lessened by supporting the breast in a bodice or bandage which lifts the breast up without pressing it back. Hot fomentations should be applied to the affected area, but care must be taken not to apply the fomentations over the nipple itself, as this tends to make the skin over the nipple soft and liable to infection.

Breast Abscess. If the obstruction of the ducts remains unrelieved the local engorgement may lead on to infection of that part of the breast, and ultimately to the formation of a breast abscess. A breast abscess, like an abscess anywhere else in the body, consists of a collection of pus or matter walled off completely from the structures which surround it. This process of walling-off, which is known as *localization*, is a desirable state of affairs, and is favoured by resting the breast in a suitable support and by hot fomentations. Once the abscess is localized it is necessary to let out the pus, and this has to be done by means of the surgeon's knife. Engorgement of the breast is therefore a serious condition, and one which even in its early stages demands medical attention. Owing to the pain associated with breast abscess it may be necessary for a while to cease feeding the baby from the affected breast. The other breast should still be used.

The infant should be put back to the affected breast as soon as possible after the abscess has been drained. This will not as a rule be for some days, as suckling will be too painful.

Cracked Nipple. The danger of softening the nipple by the application of hot fomentations has already been mentioned. Such softening may also be the result of a want of care in drying the nipple after feeding, or of allowing the infant to go to sleep during feeds with the nipple in his mouth, using the nipple as a dummy. By such means the skin of the nipple may easily become softened and 'water-logged,' and cracks then occur, similar to the cracks that may occur in the lips during cold weather. Such cracks are often extremely painful and may even necessitate temporary discontinuance of suckling. When they arise their treatment sometimes presents difficulties. The object of treatment is to disinfect the cracks and to cover them. For this purpose friar's balsam is the most useful application. The balsam is wiped

off before putting the baby to the breast. Such treatment usually suffices to effect a cure in the course of a few days. Some cracked nipples are, however, more resistant to treatment, and medical advice should then be sought. In obstinate cases additional rest to the cracked nipple is afforded by the use of soft-rubber nipple shields during the feedings. Some babies, however, refuse to suck through such a shield, and it may be necessary to discontinue the use of that breast for some days. Gentle expression of the milk is then needed to prevent engorgement. The expressed milk may be fed to the infant in a spoon. Besides being painful, a cracked nipple, if neglected, may give rise to a breast abscess.

DIFFICULTIES OF BREAST-FEEDING DUE TO THE INFANT.

The baby may be so feeble, owing to prematurity or other cause, as to be unable to suck at the breast. If able to suck, it may be unwise to allow him to do so owing to the exhaustion which results. The treatment of such a situation will be dealt with when the care of the premature child is considered. The infant may be unable to suck owing to disease or malformation of the mouth. The latter conditions will be obvious, but it may here be emphasized that a painful inflammation of the mouth, commonly due to infection with the fungus of thrush, is a frequent cause of refusal and of crying at the breast, and may easily be overlooked.

If the infant cannot breathe freely through the nose, sucking will necessarily be intermittent and difficult. The most frequent cause of nasal obstruction at this age is a mild catarrhal infection, which is best treated by clearing the nose with an alkaline lotion made of a teaspoonful each of common salt and bicarbonate of soda dissolved in half a pint of warm water. Persistent nasal obstruction should be referred to the doctor for treatment. Shortness of breath similarly calls for medical advice.

Apart from such organic conditions as have been already mentioned, a few physically sound babies are difficult to feed at the breast owing to restlessness and crying. They are said to be 'breast-shy,' and cry and turn their heads away whenever they are brought to the mother's breast. In some cases this is due to faulty suckling technique at the start, the infant having been confronted early on with an engorged breast and flattened nipple, or a too rapid flow of milk having caused him to choke. There is, however, a certain proportion of such breast-shy cases in which the cause is obscure. In any event the treatment is the same. The mother must remain calm and assured that her infant will eventually settle down. This is often difficult but is essential to success, as nervousness and worrying on her part easily communicates itself to the breast-shy infant, and will tend also to diminish the flow of milk. Some reassurance may be gained by the knowledge that in the early days of

life the infant's food requirements are small; and that, provided sufficient water is given, the infant is rarely in danger from starvation. Artificial feeding is thus the worst possible treatment for such cases. The infant who is breast-shy should be kept hungry, but not thirsty. Daily weighing will then show a normal weight curve. Four-hourly feeds are usually more satisfactory than three-hourly. The feeding should be carried out in a quiet room which has been darkened, as this helps to calm a restless child. The infant should be wrapped rather firmly in a shawl, as this also tends to soothe him. Sedative medicines may in some cases be advantageously employed, but only under a doctor's supervision. At the start of the feed milk may be expressed from the breast into the infant's mouth, and the nipple moistened with expressed breast-milk. Patient, firm management is the key to success in this type of case. A wise and experienced nurse is often of the greatest help.

ARTIFICIAL FEEDING OF INFANTS.

The feeding of infants deprived for any reason of breast-milk is a problem which parents often find perplexing. Their perplexity is due to the wide variety of methods at present advocated, to the regrettably impassioned zeal of their advocates, and to the apparently uniform excellence of the results obtained. A sober consideration of these facts, making due allowance for the exaggerations of enthusiasts and the downright lies of advertisers, leads the more thoughtful to the conclusion that the young of the human species is in the matter of diet peculiarly adaptable. Nor is this a matter for great wonder when one considers that it is his adaptability—in dietetic and other matters—that has placed man in his present position at the head of the animal kingdom. It is due to this power of the infant to accommodate himself to a considerable variety of circumstance that no one can give an unqualified answer to the conscientious parent's oft-repeated question: 'What is the *best* artificial food for an infant?' There is no best. Experience of feeding methods has, however, led to certain conclusions with regard to the average infant's needs and capabilities, and it is our object here to present these conclusions and to indicate broadly how the infant's needs may be met without overtaxing his capabilities. In this connection it should be remembered that it is not often possible to judge the suitability of a diet from its immediate effects; an infant who appears to be thriving may later show signs of deficiencies on the very diet which appeared earlier to be suiting him so well. For this reason the only advice worth following in matters of infant feeding is that based on wide experience; the alleged successful feeding of half a dozen infants on any food, patent or otherwise, is not enough to warrant the adoption of that food. Only those methods which have been tested by competent

observers on many thousands of infants shall be considered; even so there is a sufficiently wide choice.

Most artificial feeds have as their basis cow's milk. The advantages of this in readiness of supply, cheapness, and adaptability to the infant's needs far outweigh its disadvantages, so it will be assumed that the artificial food is to consist, in part at least, of cow's milk.

Grades of Milk. Cow's milk is sold to the public under the following designations:

Certified milk, the most expensive form of milk, is raw milk bottled on the farm, produced under conditions which ensure cleanliness, from cows examined by a veterinary surgeon, and tested for the presence of tuberculosis every six months. In addition the numbers and types of germs found in the milk on examination under the microscope are regulated.

Grade A, T. T. (tuberculin-tested) milk is produced under similar conditions, but a larger number of germs is permitted.

Grade A milk is similar to Grade A, T. T. as regards the limits placed on its germ-content, but no test for tuberculosis is applied to the cows, which are examined by the veterinary surgeon every three months instead of six.

Pasteurized milk is milk, supervised as to its content of germs, which has been kept at a temperature of 145° to 150° F. for half an hour.

The danger of milk as a food for infants lies in the germs which it contains, and especially in the possible presence of the germs causing tuberculosis. These germs are destroyed by boiling the milk, and this is a procedure which the present writer strongly advocates. There is, however, a certain number of well-informed people who oppose this view, the grounds for their opposition being that boiling milk destroys the vitamins together with certain ferments which aid the digestion of the milk. That the vitamins are in part destroyed is true; but they can readily be replaced from sources uncontaminated with the germs of tuberculosis. Moreover, the vitamin content of milk varies very greatly, and is not to be relied on as a sure protection from the deficiency diseases. The presence of digestive ferments in the milk is conjectural; their existence is not a proved fact, whereas the presence of harmful germs is; furthermore, the increased digestibility of cow's milk after boiling is incontestable.

The Composition of Cow's Milk. Cow's milk, like human milk, contains Protein, Fat, Carbohydrate, Minerals, Vitamins, and Water. It differs from human milk in the proportions of these ingredients and in their nature.

The *Proteins* of cow's milk amount to about 3·5% of the whole, whereas in human milk they are but 1·5%. Moreover, milk proteins

are of two classes: casein, which forms curds, and albumen, which does not. The former is more difficult to digest than is the latter. While in human milk the casein is in relation to the albumen as 1 to 2, in cow's milk the ratio is as 4 to 1. As a result the clot formed when the milk enters the stomach is much larger and tougher in the case of cow's milk.

The *Fat* content of cow's milk is the same as that of human milk, namely, 3·5%. The nature of the fats is somewhat different, and that of cow's milk is slightly less digestible. The fat content is likely to be constant if the pooled milk of a large herd is used; this is an argument against keeping an individual cow to supply an infant's needs. Jersey cows supply a rich milk with a high fat content, which makes it less suitable for infant-feeding than the milk of shorthorn cows.

The *Carbohydrate* of cow's milk is identical with that of human milk, and is all in the form of lactose or milk sugar. It is present, however, in less quantity, namely, 5%.

The *Mineral* content of cow's milk consists chiefly of combinations of calcium, sodium, iron, and phosphorus. Their total proportion is higher than is that of the minerals in human milk. The iron salts may, however, be deficient, and this may give rise to anaemia in artificially fed babies unless iron is added to the diet. This is a point which will be dealt with later. The proportions of the various constituents of cow's and human milk may usefully be contrasted thus:

	Human	*Cow*
PROTEIN (Clotting) . . .	0·4	3·1
,, (Non-clotting) . .	1·1	0·4
TOTAL PROTEIN . . .	1·5	3·5
SUGAR	7·0	5·0
FAT	3·5	3·5
SALTS	0·2	0·7

It will be apparent from a study of the figures above that by no degree of dilution can cow's milk be converted into human milk. The claim to 'humanize' milk can therefore no longer be rightly made. It is found, however, that whole raw cow's milk is not a suitable food for the average normal baby, so some form of modification is necessary, and the primary object of this modification is to present the protein of the milk in a more easily digested form.

Protein indigestion is less likely to occur if the protein is given to the child in small quantities and in a finely divided state, similar to the fine curds formed by breast-milk in the human stomach. The first of these two objects may clearly be achieved by diluting the milk with water. If a mixture of equal quantities of milk and water is made the

protein content of the mixture will be 1·75%, which begins to approximate to that of human milk. The nature of the protein will, of course, remain widely dissimilar. It is, however, found that such a diluted milk, when introduced into the stomach, clots with much finer curds than does the whole milk. There are many other methods of rendering the curd of the milk finer. Boiling achieves this end, as does the addition to the milk of a small quantity of alkali in the form of lime-water or sodium citrate. Dried milks and condensed milks are found to give a fine soft curd. The addition of lactic acid to milk causes the formation of a flocculent and easily digested curd. Peptonizing and, to a less degree, pancreatizing ('Benger's Food') are methods of pre-digesting, resulting in a more easily digested protein.

It is hard to be dogmatic in assessing the merits of these various methods of curd-modification, but it will be clear that some, such as peptonizing or pancreatizing, take up more time and require more care than do others. Of the simpler methods, the boiling and diluting of cow's milk present little difficulty, while the use of a dried milk is also widely favoured.

Dried Milks. These are of two types: the 'half-cream' milks in which a portion of the cream has been removed, and 'whole-cream,' which is prepared from unaltered cow's milk. The milk is dried by one of two methods. In the roller system the milk is run on to heated rollers, and the powder resulting from the evaporation of the water in the milk is scraped off. In the spray process the milk is sprayed into a heated chamber, and the resulting powder falls to the floor of the chamber, where it is collected. The roller-dried milks ('Cow and Gate,' 'Dorsella,' 'Ostermilk,' 'Umbrosia,' 'Glaxo') appear to have a higher proportion of their vitamin content preserved, while the spray-dried milks ('Trufood,' 'Trumilk') retain their fat in a better state of emulsification, so that the fat does not tend to form a scum when water is again added. In both processes the heating has the effect of making the protein clot in a finer curd.

The dried milks can be converted into cow's milk again by the addition of an ounce of water to a drachm by weight (about two level teaspoons) of the powder.

The chief advantages of dried milks are their digestibility, cleanliness, and facility of storage and carriage. They can be kept clean and fit for use in weather and conditions which would result in the rapid deterioration of fresh milk.

Condensed Milks. These are made by evaporating milk in a vacuum to a third of its original bulk. They are of two varieties, sweetened and unsweetened. The former has cane sugar added to it for the purpose of preserving it, and this, in the writer's opinion, renders it an unsuitable food for the normal infant. The unsweetened variety

(Nestlé's 'Ideal') has had its protein so altered by the process of condensation that it is readily digested even by debilitated infants, and is of the greatest value in the feeding of young or premature babies, or in cases of dyspepsia. It is not necessary for the normal child, and has the disadvantage that once a tin has been opened it must be used the same day or thrown away. It is reconstituted into cow's milk by the addition of two parts of water to one part of the milk.

Milk Mixtures. Even after the protein of cow's milk has been altered by boiling, drying, or condensing, it is still present in rather too large a proportion to be digested by the average infant, and on this account it is usual to dilute the milk with water. The degree to which this dilution is carried varies widely in practice, and the cause for this lack of unanimity lies in the fact that the dilution is in itself a compromise. The protein of the milk, it will be remembered, is in two forms. The object of the dilution is to diminish the proportion of the curd-forming casein; but at the same time the comparatively easily digestible albumen, which even in whole cow's milk is present in only small proportion, is also diminished. Consequently, systems of infant feeding in which the milk is diluted with an equal quantity of water are criticized on the ground that the ratio of easily digested albumen is too low, especially for infants over five months or so. The advocates of milk mixtures in the proportion of 2 to 1 or 3 to 1 are, on the other hand, accused of over-taxing the younger infants' digestive capacity. The practical success of both extremes seems to indicate that neither method is outside the adaptability of the average child, and that this is a problem where dogma has no place. It would on the whole seem reasonable to offer a very young infant, deprived for any reason of breast-milk, the more dilute feeds at first, and to strengthen the mixture as his nutritional needs increase, and his digestive capacities become accustomed to dealing with the casein of cow's milk.

It has been explained in the section on breast-feeding that the nutritional requirements of infants vary between fifty and forty-five calories per pound of body-weight, and that their fluid intake should be about two and one-half ounces per pound of body-weight per day. Thus a ten-pound baby in the first two months of life will need about twenty-five ounces of fluid food, having a nutritional value of about five hundred calories. Now the nutritional value of milk, whether from the cow or the human breast, is twenty calories per ounce.

If therefore the infant were fed on whole cow's milk, both his nutritional and fluid requirements would be adequately met. But reasons have already been advanced against feeding on whole cow's milk. If the cow's milk is diluted the infant will either be underfed or will have to take too large a volume of fluid at each feed. For this reason it is the practice to add to the diluted milk such quantities of sugar and fat

as will restore the nutritional value of the milk and water mixture without materially increasing its bulk. Such addition of sugar and fat can be made without overtaxing the infant's capacity to digest these substances, since they are in diluted cow's milk below their level in breast-milk. A concrete example may serve at this point to make things clearer. If a ten-pound baby has been given a mixture of equal parts of milk and water he will have satisfied his fluid requirements, which is another way of saying that he will probably have taken as much as he can comfortably hold, when it has had twenty-five fluid ounces in the day. But he will only have had twelve and one-half ounces of milk, or two hundred and fifty calories. His nutritional needs are five hundred calories; therefore he will be underfed. If, however, we were to add seventeen drachms of sugar to the mixture (one drachm of sugar has a nutritional value of about fifteen calories) we should, without increasing its bulk, have added about two hundred and fifty calories of nourishment, and the baby would then be having an adequate diet as far as the total nourishment was concerned. (This mixture would, in fact, be quite unsuitable for any child.) It is with this idea of restoring the nutritive value to the dilute milk mixture that sugar is added. The quantity of sugar which it is necessary to add naturally depends upon the degree of dilution of the milk, and also on the quantity of fat, in the form of butter, cream, cod-liver oil, or one of the compounded 'creams,' which is embodied in the mixture. As to the type of sugar used there is a wide choice. Milk-sugar or lactose is advocated on the plea that it is the *natural* sugar to give; the only disadvantage appears to be its cost. Glucose and dextro-maltose have their supporters, the former because it requires no digestion before absorption, and the latter because it is more rapidly assimilated than any other sugar; the advantage of these properties is not obvious. Cane sugar is widely used, and seems to be fairly satisfactory; it is readily obtainable in a high state of purity, and at a comparatively low cost.

From what has been said so far it would appear that the nutritional needs of an infant may be supplied by a simple mixture of cow's milk, water, and sugar. Inasmuch as the human body has the power of converting sugar into fat this is true (vitamins being added), and with children who, as the result of abnormality or disease, are unable to digest fat, such a procedure has sometimes to be adopted. The normal child should, however, have a certain proportion of fat in his diet; the reasons for this are, firstly, that fat of animal origin contains the essential vitamins A and D, the first of which is not only essential to growth but also protects against infections, while the second protects against rickets. Secondly, it is found in practice that an attempt to add sufficient sugar to a milk dilution to supply the total nutritional needs without fat frequently results in the production of diarrhoea and other

symptoms of sugar intolerance. In other words, the limit of the infant's capacity to utilize sugar is passed before his nutritional needs are supplied. For these reasons a complete food should have a proportion of fat, and the added fat should be of animal origin, as vegetable fats, such as olive oil and nut oils, contain no vitamins.

The quantity of fat to be included in a milk mixture must lie between, at the upper limit, the child's capacity to digest and absorb the fat, and, at the lower limit, that quantity which will contain adequate quantities of the fat-soluble vitamins. The capability to digest fat is very variable, even in the normal child, but it is important to remember in all cases that the fat added to an artificial feed differs from the fat of human milk, not only in chemical composition, but also in its physical state; that is to say, in the fineness of its emulsion. For fat occurs in milk as an emulsion or suspension of fine droplets in the watery solution of sugar and protein, and upon the size of these droplets depends to some extent the ease or difficulty with which the fat is digested.

The nature of the fat to be added is of some importance, and there is a wide choice. The cream of cow's milk has the disadvantage that, as at present sold in shops, it varies very widely in its composition according to whether it is prepared by skimming 'set' milk or by mechanical separation. If prepared by the former method it may be much contaminated by germs which have fallen into it during the 'setting' process. A further disadvantage of cow's cream is that it is as likely to be infected with harmful germs as is the milk from which it has been prepared; all the arguments against the use of raw cow's milk apply with equal force to the use of cream. If it is boiled in order to sterilize it the vitamins are in some measure destroyed.

Butter is sometimes used, but much the same argument applies.

The other available fat is cod-liver oil, and on account of its high vitamin content and its freedom from tubercle bacilli it has found wide favour. Its use, in some form, is one of the few procedures in infant feeding which has not been made a 'bone of contention' by the experts. As a result this valuable food has been used as the basis for an almost countless number of patent preparations which it would be tedious and fruitless to specify. The object of the makers of many of these compounds has been to modify the characteristic taste and smell of the oil which they contain. These properties of cod-liver oil, though nauseating to many adults, appear to have no such effect on the average infant, who will consume the necessary quantity of the oil with evident relish. A refined cod-liver oil is frequently an inert substance as far as its rickets-preventing property is concerned, and in practice it is wise to select an oil prepared by a reputable firm of chemists who have estimated its vitamin content, and publish the result of such estimation on the label of the bottle.

If the oil is to be added to the food in the bottle it is convenient to make use of an emulsion. This should contain 50% of the oil. Vitamin-containing creams, such as 'New Zealand Cream' and 'Marylebone Cream,' are also widely used. They possess the advantage of being solids which pack more easily and maintain their state of emulsion almost indefinitely. Furthermore, they contain sugar, which acts as a preservative. Their chief disadvantage is their price, which is greater than that of the simple emulsions. When using such preparations the percentage of vitamin-containing fat should be ascertained, as they contain a proportion of oils of vegetable origin. In addition, their sugar content must be allowed for when working out the proportions of a feed.

For the prevention of rickets a normal child of one month requires two teaspoonfuls, and a child of two months three teaspoonfuls, of the pure cod-liver oil a day.

Vitamin Concentrates. Recent research has resulted in the production of certain vitamins, notably A and D, in highly concentrated forms. Examples of such substances are 'Essogen' and 'Avoleum' (Vitamin A), 'Radiostol' and 'Ostelin' (Vitamin D), and 'Adexolin' and 'Radiostoleum' (Vitamins A and D). Properly used these substances mark a great advance in vitamin therapy, and are of inestimable value in certain types of case. They need, however, form no part of the diet of the normal child, and the concentrates of Vitamin D are not devoid of danger if used by the undiscriminating.

Vitamin D acts in the human body by facilitating the laying down of the mineral calcium in such places as the bones and the teeth where it is normally required. The ordinary diet of an infant contains plenty of calcium, but in the absence of Vitamin D this calcium is not properly used, and the bones become soft and bendable, giving rise to the characteristic rickety deformities. The results of over-dosage with Vitamin D are equally disastrous. In the presence of an excess of Vitamin D the deposition of calcium in the body is carried beyond the normal degree, and takes place in abnormal situations outside the bones and teeth, such as the kidneys. The writer has seen a case of stones in both kidneys resulting from gross over-dosage with a Vitamin D concentrate. Such preparations should not be used except on medical advice.

Vitamin C. This vitamin exists in the raw milk of pasture-fed cows. It is easily destroyed by heat in the presence of air, and must therefore be added to the diet of infants fed on boiled cow's milk, if scurvy is to be prevented. It is contained in the juices of citrous fruits, such as oranges and lemons, and it is essential that such juice should be given. Half a teaspoonful of orange juice may be given with an equal quantity of water every day to an infant a month old, and the amount increased as the child grows. This is usually well tolerated, and has no appre-

ciable effect on the child's digestive tract. It is interesting to note how large a proportion of mothers give the orange juice in the mistaken belief that its purpose is to keep the action of bowels regular.

If, as occasionally happens, the juice is not well taken, a valuable substitute can be prepared by baking a potato in its 'jacket.' The floury potato lying next to the skin is scraped from the skin with a spoon and made into a cream by the addition of a small quantity of milk. Three teaspoonfuls of such a cream during the day has a powerful anti-scorbutic effect.

The Feeding Bottle. There is no question that at its best the feeding bottle is a very great nuisance; at its worst it is a grave danger. Before the discovery of india-rubber the feeding bottle or bubby-pot was made in the shape of a teapot in pewter or china, with a sponge of twisted rag thrust into the spout. Through this wick the infant sucked his mixture of sweetened milk and small beer, to which must have been added a truly remarkable assortment of germs, which lived and multiplied in the depths of the insanitary teat. With the introduction of india-rubber teats and the principles of asepsis the feeding bottle became less of a germ trap, but for a time it was not uncommon to see the teat connected to the bottle by a long and uncleanable rubber tube.

The modern bottle is of two types. The 'Soxhlet' bottle is cylindrical and has a rubber teat at one end. The boat-shaped bottle is open at both ends, on one of which is placed the teat, and on the other a rubber valve, which allows air to enter the bottle as the milk is sucked out. It is claimed for this type of bottle that it is more easily cleaned than is the 'Soxhlet.' Certainly a stream of water can be directed *through* the bottle, but experience does not show that the other type of bottle presents any great difficulty in cleaning. The disadvantage of the boat-shaped bottle is that it has two rubber attachments instead of one, and as the rubber is perishable, especially when frequently boiled, this constitutes an added complication. The most obvious advantage claimed for the boat-shaped bottle lies in its rubber inlet valve. In unskilled hands this is not an unmixed blessing, as it allows the feed to be given with the minimum of attention. Artificial feeding, like breast-feeding, demands the close attention of the mother or nurse throughout the feeding. Many failures wrongly attributed to the contents of the bottle are in reality due to the want of skill of the person who handles it.

Further Details of Artificial Feeding. It matters little whether the feeds are made up as needed, or the whole day's ration made up in the morning. When dried milk is being used or where facilities for safe, cool storage of the milk mixture are wanting the former course is the better. By making up the whole day's mixture at one time inaccuracies in measuring the various ingredients will be minimized.

Absolute sterility of all vessels used for measuring and storing the mixture is important. This can best be achieved by boiling. Boiling water kills germs, but it is of course useless to place a vessel in boiling water and then dry it with a cloth which has been hanging in the nursery or kitchen, and thus been exposed to dust and flies. After the food has been prepared it must be protected from contamination by a suitable cover, and kept in a cool place until required for use. The baby's food must not be tasted. The rubber teats, like the bottles, must be scoured inside and out after use, then sterilized by boiling water, and stored in a covered vessel which has itself been sterilized.

Before being given to the infant the food must be at the right temperature, which is about 98·4° F. The importance of this point is often overlooked. During the feeding, which should last about twenty minutes, the food will tend to cool. This cooling can be minimized by covering the bottle with a flannel jacket. A pot of hot water should be at hand, and the bottle may be stood in this for about half a minute every three or four minutes to raise its temperature again.

Such pauses in the feeding are a help to the infant, who then has an opportunity of regurgitating any air he may have swallowed.

The ease with which the milk mixture flows from the teat is of some importance, and must be adjusted to the sucking powers of the individual baby. Some strong babies will suck so powerfully that the milk will flow from the bottle faster than they can swallow it, and choking results. Other babies are feeble suckers, though quite capable of swallowing the whole feed in twenty minutes, and a larger hole must be made in the teat in these cases. On the average a rate of one drop every two seconds, when the bottle is inverted, is found satisfactory, but no rule can be laid down. The hole is made in the teat with a red-hot needle. If a cold needle is used a valve-like opening usually results, which makes sucking very hard work, if not actually impossible.

MIXED FEEDING.

At the age of about six months food other than milk should be introduced into the diet of both artificially and breast-fed infants. This extra food may conveniently take the form of a cereal, such as oatmeal or barley. Small quantities should be given at first of the consistency of a thick gruel; this should always be given by spoon, as in this way the child learns early to take semi-solid food and, in the case of the breast-fed, a bottle need then never be used. At seven months green vegetables should be given as a purée. Care must be taken to avoid the inclusion of large and indigestible pieces. Green vegetables are a valuable source of iron, and this element is of great importance to the artificially fed. Seeded raisins also contain iron, and may well be given at about seven or eight months.

At eight or nine months the breast-fed baby should be weaned on to a mixture of milk and water, with added sugar. If mixed feeding has been introduced at six months the use of a feeding bottle should not be necessary; the child should take well from a cup and spoon. Weaning should be accomplished gradually, one breast-feed being replaced at a time, and a change made every week; in this way the process is spread over a period of four weeks, and the infant is given time to accustom himself to the change in diet. Opinions vary widely as to the strength of milk mixture to be given at this age. Generally speaking the infant who has been receiving starch in some form from the age of six months can be weaned to a stronger mixture than the infant who has had nothing but breast-milk. In any case, after weaning is accomplished the mixture should be gradually strengthened by the omission of water, so that its bulk is diminished as other foods are introduced.

At about eight months, or earlier if teeth appear, the child should be given baked crusts to chew.

At the age of nine months marrow-bone soup may be added to the green vegetables. At ten months milk puddings may be given, with the addition of cooked fruit, such as baked apple. From now on, the diet should be gradually modified until, at one year, the child is taking the bulk of his food at three meals, with a drink of milk at night.

FEEDING DURING THE SECOND YEAR.

Attention to the diet of the child during the second year is so important that it is surprising to find how frequently it is neglected, and the child allowed to 'take what is going.' At this stage of life habits are easily formed, and a habit of refusing food, often a gesture of self-protection, owing to the unsuitable nature of the fare provided, may easily lead to a state of chronic malnutrition. Second only in importance, then, to the choice of good and suitable food, is its preparation in an attractive and palatable form. Only in this way can the development of faddiness be avoided.

During the second year table manners must be inculcated. Children who are allowed to break off in the middle of a meal to play with toys, or who are pursued round the room by an anxious adult carrying the food and uttering entreaties, seldom take enough to satisfy their needs. Eating between meals should not be allowed. The child has a natural craving for sweets, and this should be satisfied, but at mealtimes; thus there is no reason why the midday meal should not conclude with a stick of barley-sugar or a boiled sweet.

Soft pappy food should be avoided as far as possible, and every meal should include some dish which needs chewing.

Dietaries for children are so numerous that it has been the present writer's object throughout to avoid details. The following diet-sheet

is included only so as to save much wearisome reading, and to serve as an outline, to be filled in and augmented according to individual ingenuity and culinary capability.

On waking 6–7 *a.m.*	Drink of orange juice and water. Later a raw apple.
Breakfast 8–9 *a.m.*	Baked toast with butter or dripping. Porridge or dried cereal. Stewed or pulped fresh fruit or baked apple. Milk to drink.
Dinner 12–1 *p.m.*	*First course.* Bone and vegetable soup or gravy, stiffened with breadcrumbs, potato, green or root vegetables; or lightly cooked egg, or white fish, or minced rabbit, or minced chicken, or brains, } with vegetables. *Second course.* Milk puddings, or custards, or junket with fruit and jelly. Light-steamed puddings with treacle or honey. Milk to drink. Piece of raw apple to end meal.
Tea-Supper 5–6 *p.m.*	Toast and butter, with treacle, honey, or jelly. Milk to drink, flavoured with chocolate or marmite. Cereals if still hungry.

A drink of milk may be given at 10 p.m. if the child is hungry, but this should be discontinued during the second year.

The above table, as has been said, is not supposed to be exhaustive; nor should all the foods mentioned therein be immediately introduced on the child attaining the age of one year. Their introduction should be spread over the second year, and new foods should be given in small quantities at first. Though all foods have to be minced at the age of one year, later they can be given in coarser form.

II—PROBLEMS OF SEX AND MARRIAGE

Puberty

In the first decade of life the differences between boys and girls do not as a rule prevent their competing on equal terms in physical and mental activities. Somewhere about the age of fourteen, however, puberty occurs; and from that time onwards there is observable a fundamental change in outlook which is usually accompanied by a divergence between the sexes in physical and mental capacities.

In boys, at about the age of fifteen or sixteen, marked changes begin to show themselves. Hair becomes noticeable on the face and the armpits and the pubes and, often, on the chest and other parts hitherto relatively hairless. The bones become markedly thicker and longer, and the muscles increasingly developed. The neck becomes thicker, and the nose longer. The voice 'breaks,' owing to the growth of the larynx. All these, and other, puberty developments are associated with the maturing of the male sex glands, the testes. It is well known that if, just before puberty, these glands are removed by the operation known as castration, none of these changes occur. Formerly castration was, indeed, frequently performed on youths in the Vatican choir in order to preserve the soprano quality of their voices. The physique of eunuchs employed in connection with Oriental harems further exemplifies the direct relation between the activities of the sex glands and the development of those physical and psychic characteristics that distinguish average man from average woman.

A parallel revolution occurs in the mind and body of the girl at puberty. Her hips become fuller, the breasts increase in size, and hair appears in the armpits and on the pubes. Menstruation—or the 'periods'—commences. Each month an ovum ripens and escapes from one or other of the ovaries, and passes along one of the Fallopian tubes into the womb. This escape of a ripened ovum, termed ovulation, is the fundamental physical fact of the woman's sexual life. Unless this ovum is fertilized by sexual congress, it escapes from the womb and is lost. Nearly a fortnight after ovulation, menstruation occurs; and this must be regarded as a 'missed pregnancy.' It will thus be seen that menstruation is a cycle usually determined by ovulation. If the period commences on a Monday, being the first day of the month, ovulation should occur about a fortnight later, and the next period on the fourth Monday, the twenty-eighth day of the month.

Although the periods are largely determined by ovulation the ovaries and ovulation are both under the control of the nervous and endocrine systems, and particularly of the front part of the pituitary gland.

Menstruation

In this country the periods usually begin at about the age of fourteen years, although they may first occur as early as nine or as late as twenty-four years. They should return at intervals of twenty-eight days, last for three to five days, and cause no pain. When they first start they are likely to be irregular, particularly if the girl is not previously warned about them, or if she is overworked at school. Although there should be no pain at the time of the monthlies, many girls do suffer pain which is sometimes very severe. The pain may be situated in the lower part of the abdomen, in the back, or to one side. The pain usually comes on just before the period commences, or during the first day of the flow, when clots may be passed—though these are not normal. In some girls the periods are very scanty; in others, they are very heavy and last for a week. It cannot be sufficiently stressed that the widest variations in this function are compatible with perfect health. If the pain is very severe or the loss heavy, a doctor should be consulted. The amount of iron in the body is extremely small; and if the girl loses too much at her periods she is apt to become anaemic.

Irregularities in the periods are due to two main factors: (*a*) Structural, (*b*) Mental. Very little need be said concerning the structural defects, except to say that the uterus or womb may be under-developed; and this and other similar errors are more easily corrected the earlier the girl consults the doctor. The effect of the mind and emotions on the periods is often very profound. It is, for instance, a very common experience for a young woman who leaves home and commences some form of work to miss her periods for several months, during which time she may put on a considerable amount of weight. Also, the periods may be stopped by a hot or cold bath, or by putting the feet into hot or cold water, if the girl is unaccustomed to bathing at these times. Then, too, a girl who suffers severe pain during menstruation may be relieved completely by a change in her circumstances, or by falling in love. There can be little doubt, therefore, that the mind may affect the rhythm, the flow, and the symptoms, associated with menstruation.

HYGIENE.

In the Pentateuch, strict instructions were given to women to segregate themselves and to consider themselves unclean during the periods. Indirectly, rest was enjoined. This custom, still observed to a certain

extent by Jews (and by many primitive peoples), may in some measure account for the extreme fertility of this race, and possibly for the fact that cancer of the womb is relatively uncommon in Jewesses. The extreme opposite view is favoured by many to-day. Women enter for athletic competitions, tennis championships, and even swimming races, whether or not they are menstruating. The fact that a considerable number of girls can perform extreme physical exertion during menstruation without apparent ill effects does not mean that they will not pay the price in later years. It is an interesting fact that the majority of women who run cross-country races or cycle a hundred miles during their periods will not dare to take a bath at that time, whereas others do not mind bathing but would not indulge in any violent exercise. From the medical point of view there is no valid reason why a girl should not have a warm bath and live a normal life during her periods; although prudence suggests that severe physical exercise should be avoided. She should take a tepid bath each morning of her life, rub herself briskly with a rough towel, and then spend five minutes doing simple Swedish exercises. She should sleep on a relatively hard bed, with her windows wide open, and not go out to too many dances or visit the cinema too frequently. Trouble during menstruation is frequently due to late nights and insufficient sleep. This is particularly true of girls who have to earn their living, although it applies also to those who spend their energies trying to make life worth living. If the 'losses' are heavy it is wise to take periodic courses of iron. The best preparation to take is Blaud's pills, which can be obtained from any chemist. Two may be taken after each meal for three months. Iron, however, tends to cause constipation, and it may be necessary to take senna tea during the course. The vast majority of women, whether or not they suffer pain, are not able to concentrate so effectively or to engage in active mental pursuits so successfully during menstruation as at other times.

Marriage

There are three main reasons why people marry: (1) Because they fall in love; (2) For convenience; (3) Because of physical sexual attraction. Of these three reasons, the last is by far the least satisfactory. True love is compounded of many ingredients which include physical attraction, but it is hallowed by spiritual affinities. Happy marriages may occur between individuals who have intellectually little in common, but rarely if they are divided by religion or colour. Marriage is a complementary blending, and can only be truly successful when both parties obey the Christian precept, 'By love serve one another.' The third reason for marriage is unsatisfactory just because both husband and wife marry for what they can get and not what they can give.

Sexual attraction tends to decrease with its 'satisfaction,' which can occupy but a small fraction of time; and, unless it is replaced or supported by friendship, attraction may turn into loathing and hatred. Further, the man or woman who marries for sex satisfaction is likely, after a while, to be attracted more powerfully by another individual. It cannot be too strongly emphasized that sexual passion tends almost invariably to decrease with its gratification. Marriages of convenience, on the other hand, are often moderately successful on a low aesthetic plane. Neither partner expects too much from the other. The marriage settlement unites two neighbouring farms, or results in mutual advantages to both partners, and it pays to make the marriage a going concern. Marriage, in this country, is on the whole a very harmonious institution; for, while the number of really ideal unions 'made in heaven' may be small, the vast majority are tolerably harmonious. The failures of the marriages of 'bright young things,' which never possibly could have been successful, are advertised in the divorce courts; while the incomparably greater number of truly happy marriages are only known to the limited circles of friends. Laziness and selfishness wreck more homes than do any other faults. It is more important for a man to know what a girl is like at breakfast; what is her attitude to children, and what their reaction to her; how she treats the old and infirm; and what is her ability to cook and housekeep, than to be carried away by the success she creates at a ball, or the degree she obtains at a university.

PHYSICAL FACTORS.

There are people who urge that both partners should be medically examined and present each other with a medical certificate before they are married. There is much to be said in favour of this view, although there are not a few obvious objections.

In the first place, through the fault of one or both partners, the marriage may be incapable of being consummated. The woman may be imperfectly formed, the entrance to the vagina may be blocked by a membrane, or the entrance may be narrow and the pain of coitus so great that the act may not be allowed. Most of these difficulties may be removed by medical attention. The male partner, on the other hand, may be incapable, for physical or psychological reasons, of consummating the marriage. If it be proved that sexual congress cannot occur, the State is willing to cancel the marriage, and even the ecclesiastical authorities regard the marriage as null and void.

In the second place, one or other of the partners may be suffering from one of the venereal diseases; the other partner may catch it, and endure suffering for years. Of a man or woman, who, knowing himself or herself to be suffering either from syphilis or from gonorrhoea, marries

without divulging the fact, it is impossible to speak too harshly. The trouble about the venereal diseases is that it is very difficult to know when they are cured. An individual may honestly believe himself to be perfectly free from disease, and yet convey it to his bride. From both the medical and the sociological points of view, the examination of both partners by an experienced physician would be of inestimable value in preventing individuals with venereal disease from causing tragedy in a new home. It is, however, obvious that until recently the vast majority of girls have not even known of the existence of these diseases, and it would be difficult to persuade public opinion to regard such a development with favour. Whether or not it ever becomes the law of the land that partners shall produce medical certificates before marriage can be solemnized, it would be well for parents to insist on such certificates being produced before they consent to their daughter's marriage if they have any suspicions that the sexual life of her prospective partner has ever been irregular.

There are a number of other physical and psychical conditions which would render an individual unsuitable as a mate. In the first place hereditary conditions must be considered. Certain types of mental disease are very likely to be hereditary, and may possibly skip one generation and appear in the next. It is always a risky procedure to marry an individual who has more than one direct relation in an asylum. There is, for instance, a disease called Huntington's chorea, now more common in America than in this country. A thousand persons with this terrible disease were studied and it was found that they were all descendants of about six individuals, three being brothers, who migrated to America in the seventeenth century. Besides mental diseases and certain forms of paralysis there is no doubt that excessive alcoholism damages the germ plasm and that this damaged plasm is hereditary. Chronic and severe alcoholism in a family may make the children undesirable partners in marriage. Only one other form of hereditary disease will be mentioned. Haemophilia is a disease which occurs only in males, who are called 'bleeders.' A scratch or the extraction of a tooth may result in a fatal bleeding. This disease, although it only occurs in males, is transmitted only through the female, and thus skips a generation. Some or all of the male children of a woman who is the daughter of a 'bleeder' will probably be 'bleeders.'

Finally, there are a few general medical conditions which make a man or woman undesirable as a mate. Epilepsy and gross heart disease obviously render a woman unsuitable to become a mother, while chronic kidney disease, which may remain undetected, is a serious complication of pregnancy.

But prudence can be overdone. Some eugenic enthusiasts would, if they had the power, arrange marriage on a card-index system; but

men and women are not cattle; and the intellectual, as distinct from the physical, quality of the offspring appears to run independently of any known laws.

STERILITY.

Sexual congress may at first be attended with minor difficulties. The entrance to the vagina may be small, and the defloration or breaking of the maidenhead may be attended with pain or bleeding. Occasionally, though rarely, the bleeding is so severe as to require medical attention. The act, in its highest form the sublimation of the love of a man for a maid, has—or should have—spiritual as well as physical qualities. Few married people can safely enjoy coitus more than twice a week; and for many once a week may be too often. After the act, the partners should fall asleep; subsequent wakefulness is a sure sign that it has been improperly or unsatisfactorily performed. Mental or physical fatigue the next morning is a definite indication that sexual congress is occurring too frequently. On the other hand, more unpleasant symptoms may occur if two individuals sleep together and, for any reason, refrain indefinitely from sexual intercourse.

One of the purposes of marriage is that the union may be fruitful. About one out of every fifteen marriages remains barren. In some cases the woman, in others the man, is at fault; but in the majority of cases the 'blame' must be apportioned between the two partners. It has been shown in a previous chapter that the biological reason for sexual intercourse is the necessity for the transference of protoplasm from the male to the ovum. Either the spermatozoon or the ovum may be unhealthy, or the sexual act may be improperly performed. The Fallopian tubes may be blocked, or other mechanical factors may prevent the spermatozoon from reaching the ovum. In some cases nothing can be done to remedy matters. In others, expert medical attention may render a barren marriage fertile. Although it is not excessively rare for a couple to have their first child after being barren for fifteen to twenty years, it is advisable for married people to consult expert medical opinion if at the end of two years after the marriage pregnancy has not occurred. Coitus is likely to be most fruitful when performed between the tenth and fourteenth days after the commencement of the menstrual period.

Pregnancy

DIAGNOSIS.

If a healthy married woman whose courses are regular misses a period, the probability is that she is pregnant. Occasionally, scanty periods may occur during the first three months of pregnancy and upset

all calculations. The duration of pregnancy is ten lunar months, and the date of the expected confinement may be calculated by adding twelve days to the date of the commencement of the last period, and counting back three calendar months. If, for example, the last period commenced on the 1st April the confinement may be expected on the 13th January. It is important that married women should note each month the dates of their monthlies, otherwise it may be extremely difficult to know when baby is to be expected.

There are two symptoms often associated with early pregnancy. One is a frequent desire to pass urine, and the other the occurrence of shooting pains in the breasts. At the end of the sixth week of pregnancy sickness often occurs, and lasts for six weeks to two months. The sickness is generally felt when the woman gets up in the morning. If she stays in bed, and takes a cup of tea and some dry toast, the nausea passes away, and does not recur until the next morning. In some cases, however, the sickness comes on at night when the patient goes to bed. More rarely, spells of nausea occur at intervals through the day. In the worst cases the patient cannot even keep water down, but vomits almost continuously.

Some authorities regard morning sickness as neurotic—or due to 'nerves.' Inasmuch as over 50% of all pregnant women, the world over, suffer from this troublesome symptom, it may be assumed that this explanation does not represent the whole truth.

A doctor is usually in the position, as the result of an internal examination, to say whether or not a patient is pregnant. There is now a test for pregnancy—called the Ascheim-Zondek test—which is remarkably accurate. After the fourteenth week of pregnancy the X-rays show the foetus. Indeed, the X-ray picture offers the earliest absolute evidence of pregnancy.

NORMAL PREGNANCY.

When once the woman recovers from morning sickness she should enjoy perfect health, and many women never feel so well as towards the end of pregnancy. The only disadvantage is the gradually increasing size of the womb, which makes locomotion difficult, and interferes with the breathing and often with the digestion.

At the end of the twenty-sixth week the top of the womb is level with the navel. The level at this date affords the only accurate physical means of estimating the date of the confinement. By the end of the thirty-sixth week it reaches to the bottom of the breastbone. At this stage it pushes up the diaphragm, displaces the heart, and interferes with the breathing. Further, the movements of the child are sometimes tumultuous, and disturb the sleep. At the end of the thirty-sixth week the head ought to enter the pelvis, thus allowing the womb to fall

downwards and forwards. This change makes breathing and walking much easier, but increases the frequency of the desire to pass water. The general health of the woman ought then to be excellent, the sole disadvantages being due to the bulk of the pregnant uterus.

CLOTHES.

The pregnant woman should avoid wearing corsets or any supporting band. If, however, especially towards the end of the day, the weight becomes intolerable, support and relief may be obtained by an obstetric belt. Elaborate and costly belts may be purchased, but equally satisfactory results are obtained from a belt made of ordinary towelling. The whole secret is to secure support for the lower part of the abdomen. On no account should garters be worn, as varicose veins are apt to appear during pregnancy. Garters, by compressing the skin veins, increase this tendency.

EXERCISE.

The pregnant woman may take any exercise to which she is accustomed, so long as she does not become unduly fatigued by it. Walking, swimming, cycling are all permissible, but hunting, violent tennis, or serious golf, are inadvisable. Abortion or miscarriage may follow any violent or sudden strain, particularly during the early months of pregnancy. There is, moreover, a well-founded belief that miscarriage is more likely to take place at those times when the periods would have occurred if the patient were not pregnant.

DIET.

The diet during pregnancy is of the utmost importance. The foetus requires a large amount of various substances, of which the mother has not too large a store. Assuming the woman is perfectly healthy when she becomes pregnant, she should take the ordinary diet to which she is accustomed. Towards the end of pregnancy, meat should be taken not more often than once in the day; although fish, particularly herrings, may be taken as often as desired. Plenty of fruit, especially oranges, and of salad and vegetables of all kinds, should be included in the dietary. The woman should drink at least a pint, preferably two pints, of milk each day, and take plenty of eggs and cheese. A teaspoonful of marmite, a dessertspoonful of a good brand of cod-liver oil, and two glasses of water between meals, would make the diet complete. If she is anaemic at the beginning of pregnancy she should take two Blaud's pills half an hour after each meal.

BOWELS.

Many women suffer from constipation when they are pregnant. There are two golden rules to be observed if this distressing complaint

is to be avoided: (1) To seek relief with regularity; (2) To drink plenty of water. The stomach is in nervous communication with the beginning of the large bowel. The breakfast entering the stomach after the night's fast sets up a desire, some half-hour later, to go to stool. If this summons is neglected the desire and the ability to empty the bowels pass away, and the opportunity is lost. Secondly, water is absorbed from the large bowel so that the motion becomes hard and difficult to pass. It is for this reason that it is desirable to drink two or three glasses of water a day, between meals. In order to correct a long-standing misuse of the bowels, it may be necessary to take medicine for a few weeks; although this may often be avoided by suitable exercises or massage. Liquid paraffin and senna tea are two drugs relatively safe to take for this purpose. Liquid paraffin acts by lubricating the bowel. Take two tablespoonsful of oil morning and evening for one week. Then leave out the morning dose. At the end of the second week one tablespoonful at night should suffice. There is one warning to give. The oil may leak from the bowel unexpectedly, and it is therefore advisable to wear a pad for the first fortnight. Should the paraffin for any reason be unsuitable, senna tea may be used. Buy some senna pods, and keep them in an airtight tin. Take ten pods, let them stand in a half-tumbler of cold water all day, and drink the tea before retiring. Increase or decrease the number of pods as necessary. The milder saline aperients, taken in plenty of water, are favoured by some. They are relatively harmless. It should be borne in mind that the idea is to recover the normal bowel routine, and all drugs should be discarded as soon as possible. If a woman is regular before she becomes pregnant, she will not have to use any drug during the first half of her pregnancy. Even later, half a lemon squeezed into a cup of cold water, unsweetened, and drunk during the night, may avoid the necessity for any drug. It is impossible for any individual to enjoy good health if constipated; but during pregnancy constipation may be a source of real danger.

URINE.

The bowels get rid of unwanted food, the kidneys excrete the waste matter resulting from bodily activities. The vast majority of women never have their water tested until they become pregnant. It thus happens that many with Bright's disease or chronic inflammation of the kidneys become pregnant without knowing that their kidneys are not normal. Then, too, pregnancy in a certain number of cases is associated with kidney trouble, not previously existent. It is therefore desirable for every woman, so soon as she knows she is pregnant, to consult her family physician or midwife, or to attend the ante-natal clinic of a well-run maternity hospital. She should take notice of

the amount of water she passes each day. If, towards the end of pregnancy, there is a serious falling off in the amount, the condition calls for immediate medical care.

MINOR AILMENTS OF PREGNANCY.

Teeth and Gums. The gums may become swollen, have a strawberry-like appearance, and bleed easily. The teeth may give trouble, or one or more become decayed. If the teeth are sound at the commencement of pregnancy they may be preserved if plenty of calcium (or lime salts) is taken in the diet. If two pints of milk and a dessertspoonful of a good brand of cod-liver oil are taken each day, there will be no need to worry about teeth.

Hair. Not infrequently, during pregnancy, the hair loses its glossiness and tends to become brittle and fall out. Similarly, the finger nails may become brittle and tender. Milk and cod-liver oil will prevent trouble with the hair and finger nails.

Haemorrhoids or Piles. This troublesome condition if normally present tends to become worse during pregnancy. The essential thing is to avoid constipation and straining at stool. No surgical interference can be considered until the child is born, but much relief may be obtained by medical treatment.

Swelling of the Feet. Anybody who stands on his feet long enough will get swelling of the feet. The bulk of the pregnant womb presses on the veins of the legs and often causes swelling of the feet which, however, normally disappears after a night's rest. If the swelling persists, and especially if it occurs also in the upper part of the legs, the arms, or the face, medical attention must be obtained.

Varicose Veins. If a woman is normally troubled with varicose veins they will get much worse during pregnancy. Sometimes they first appear during pregnancy. Valuable support may be obtained from elastic bandages applied in the morning before getting out of bed. The expectant mother, so suffering, should recline for a good part of every day, and should when sitting make a point of resting her feet on a chair which is higher than the one she occupies. Occasionally the veins become enormous, and affect the private parts. If at all possible such a patient should stay in bed until the child is born. Should any of the veins burst the bleeding may be very alarming. In such event take two clean handkerchiefs, press firmly on both sides of the bleeding point, and maintain the pressure until the doctor arrives. After the baby is born the question will arise as to whether it is expedient to have the veins injected or removed.

Indigestion and Water Brash. As the womb increases in size it leaves less room for the stomach to expand when food is eaten. Therefore women, towards the end of pregnancy, frequently suffer from indi-

gestion, with regurgitation of fluid into the mouth. It is important that the bowels be kept well opened and that no heavy meal be taken at night. Indeed, heavy meals should at any time of day be avoided. A teaspoonful of sodium bicarbonate in a little water taken shortly after food sometimes relieves the discomfort of this sort of indigestion. The juice of half a lemon in a half-cup of water taken at night, and unsweetened, is helpful.

Cramps. Towards the end of pregnancy troublesome cramps may occur in the calves of the legs or in the thigh muscles. They usually occur at night, and cause the patient to get out of bed and walk round the floor. Besides being extremely painful, they affect the general health by disturbing the sleep. If cod-liver oil and two glasses of milk are taken daily from the beginning of pregnancy, cramps will rarely occur. They may, if necessary, be successfully treated by an injection of calcium.

Itching. Occasionally itching, which may be general or localized in the private parts, proves a distressing symptom. The urine should be tested to see whether it contains sugar, and the limitation of this substance in the diet may clear up the symptom. The localized form is frequently due to excessive moisture and discharge from the vagina. The parts should be washed with warm water, and carefully dried with a soft towel every time a visit is paid to the lavatory. The parts should then either be dusted with ordinary talcum powder or lubricated with cream. Sitz baths of weak potassium permanganate may prove helpful. Douching should not be carried out except under the orders of a doctor. The generalized form, which is not associated with sugar in the urine, is probably due to some defect in the diet, and consequently does not respond to ointments. It is unlikely that a woman who, during the whole of her pregnancy, takes the diet already suggested, will ever be troubled with this complaint.

High Blood-pressure. The blood-pressure is not usually significantly affected by pregnancy. Occasionally it may be lower than normal, but more often it becomes raised. This increase in the blood-pressure is important to detect, as it may be associated with albumen in the urine. In this case the patient should place herself under medical control.

It will be seen from the short description given above that a small percentage of pregnant women are liable to suffer from certain unpleasant disturbances, some of which (e.g. varicose veins, haemorrhoids, swelling of the feet) are due to mechanical factors, others to dietetic deficiences (e.g. trouble with the teeth, hair and nails, cramps, etc.), and yet others to pregnancy toxaemia.

Any or all of the following symptoms should cause the woman to visit the doctor, or the hospital, without delay: (*a*) headache; (*b*) dimness of vision or sudden blindness; (*c*) severe pains in the upper part

of the abdomen; (*d*) marked swelling of the face, arms, and legs; (*e*) a sudden or noticeable decrease in the amount of urine secreted.

A toxaemia of pregnancy requires expert treatment, preferably in hospital. There is no general agreement as to the cause of this strange 'disease,' but the majority of doctors believe that it is somehow bound up with the diet. It is certain that it may be generally avoided by taking the diet already described, and by avoiding constipation.

Haemorrhage. Any bleeding during pregnancy, however slight, is abnormal, and should lead the expectant mother to have a thorough medical examination without delay. In the early months, such bleeding may denote a threatened miscarriage. In the later months, it indicates the possibility that the after-birth is in part situated below the head of the baby. The condition may present extreme difficulties. It may be necessary to remain in bed under the closest observation for several weeks.

Vaginal Discharge. Many women suffer from a whitish vaginal discharge, which increases during menstruation. It also often increases considerably during pregnancy. It should be known that the discharge may be due to gonorrhoea, and consequently a source of danger to the eyes of the baby as it is being born. Some doctors are of the opinion that a heavy vaginal discharge makes a woman more likely to suffer from puerperal infection or child-bed fever, but there is little evidence to support this supposition. Much may be done to decrease the amount of the discharge by medical treatment.

Childbirth

Labour is a physiological process and can be completed in 90 per cent of all cases without any medical aid. On the other hand some cases require the most expert skill if disaster is to be avoided. The essence of the problem of childbirth is summed up in these two sentences. There is universal agreement that child-birth is safer both for the mother and the child if it is quite spontaneous. The art and skill necessary to know which case can be left to the natural efforts of the mother can only be acquired after long and tedious apprenticeship. The modern tendency is needlessly to use operative procedures, which save time and anxiety, but which often result in loss of life.

During recent years the public has been made aware of the serious mortality associated with child-birth. Various commissions have been set to work, and have contributed their reports, but the net result would appear to be the fostering of a state of alarm amongst the people without the slightest improvement in results. The facts of the situation are relatively simple. From four to five women out of every thousand who give birth to living children in England and Wales each year die

as the result of child-birth. So far as can be ascertained the figures are little or no better than they were at the end of last century.

These deaths may be divided into three main categories: (1) toxaemias; (2) accidents; (3) puerperal infection—or child-bed fever. Whereas the toxaemias first occur towards the end of pregnancy, and usually offer time for their consideration and treatment, the accidents and infection occur at the time of delivery. They not only require great skill in treatment, but unlimited time. For instance, a common cause in both groups of deaths is a mild degree of contracted pelvis. The bones of the mother's pelvis are smaller than normal, and the question is whether the baby's head can go through. It is relatively very simple to perform Caesarean section (or to deliver the baby through a cut in the mother's abdomen), though this operation has its dangers. It is very tedious and requires much skill and judgment to wait and watch the progress of labour. If the child can be born spontaneously it is much safer for the mother, but the obstetrician may have to spend hours in careful watching to know exactly when to interfere.

The best solution of the problem would be to encourage 90% of the patients to be delivered by midwives, and to make provision for the remainder to be attended by skilled obstetricians. At present over 50% of all women are delivered by midwives alone. A large number are attended by the family doctor, and only a relatively small number by really skilled obstetricians. The great advantage of delivery by the midwife is that she is not allowed to carry out any operative procedure, and is content to wait for the normal course of events to occur. Although the training and organization of midwives in this country leave much to be desired, the majority are able to conduct normal cases with safety. When the midwife gets into difficulties she sends for the family physician or some general practitioner. Many of these family doctors become expert obstetricians, but the fact remains that the medical student frequently conducts fewer than ten confinements before he becomes qualified. Moreover, patience is the essence of good midwifery; and it is impossible for the busy and successful practitioner to afford the necessary time without neglecting other needy patients. The result is that instrumental interference is often applied unnecessarily, to the greatly increased risk of both the patient and her child.

A careful consideration of these arguments leads one to the conclusion that the best way in the interests of all parties would be to build a number of large maternity hospitals, each responsible for, say, two thousand patients a year. Such hospitals would provide enough work to occupy the time of expert obstetricians, who would be able to train disciples. Small maternity hospitals are relatively dangerous, and the institution which is not large enough to demand a resident

specialist obstetrician should be pulled down. It is infinitely safer for a difficult case of midwifery to travel fifteen miles in an ambulance to reach an expert than to travel two miles to reach a poorly skilled obstetrician. If the midwife is in difficulty she ought to be in a position to summon an ambulance and send the patient to the nearest maternity hospital. The main arguments may be summarized as follows:

(1) Normal, spontaneous labour is infinitely the safest method of delivery, and all operative procedures are fraught with risks.

(2) The proportion of abnormal cases is so small that the possible number of expert obstetricians must remain strictly limited.

(3) An individual can only become an expert obstetrician through serving at least three years' apprenticeship in a large maternity hospital.

(4) All maternity hospitals must be large, in order to occupy the whole energies of specialists, and permit of their training disciples.

(5) Modern transport is such that a very small number of large well-equipped hospitals could serve the whole of England and Wales. All small maternity departments and small maternity hospitals should be abolished.

ANTE-NATAL CARE.

This subject has been left to be considered separately. Ante-natal care is a modern development, and was originally instituted for the benefit of the unborn child, and not for the expectant mother. All the stress to-day is laid on the care of the pregnant woman. If properly carried out, ante-natal care should be a tremendous advantage in the practice of obstetrics. In the first place, it permits the discovery of all women suffering from heart and other diseases who ought never to have become pregnant. Then it allows the kidney functions and the blood-pressure to be investigated. When adequately carried out, it ought to be possible to detect cases which would, without treatment, end in labour convulsions and Bright's disease. Lastly, it is possible to segregate those women with small pelves, and send them for expert investigation.

Ante-natal care, while being thus potentially beneficient, is, in fact, fraught with many dangers. If ante-natal care were left to conservative and skilled obstetricians, it would be among the most beneficent developments of the century; but, as this is not the case, it has undoubtedly led to an enormous amount of meddlesome operative interference.

LABOUR.

By labour is meant the process by which the child is born into the world. It is divided into three parts: (*a*) the stretching of the mouth of the womb to allow the child to pass through; (*b*) the passage of the child through the pelvis into the world; (*c*) the delivery of the after-

birth. The whole of labour normally requires between a hundred and a hundred and fifty 'pains,' and occupies about eighteen hours in the case of a first child. Labour 'pains' may not be painful, and many women deliver themselves of their first-born without suffering any pain. There is not the slightest doubt that fear, conscious or unconscious, increases the severity and decreases the efficiency of the pains. For this reason it is a great pity that mothers and midwives so often put fear into the heart of the young woman who is shortly to become a mother. It is regrettable also that benevolent people have stressed the pain of child-birth in their well-intentioned but misguided efforts to secure the widest use of anaesthesia during child-birth. There is no anaesthetic which is absolutely safe. Even if the yearly six hundred thousand expectant mothers in England and Wales were given anaesthesia by the most skilled anaesthetists, there would be an appreciable mortality from the anaesthetic alone. It is not practicable for all these women to secure the services of skilled anaesthetists, so that in practice the dangers of anaesthesia would be much greater.

The pains during child-birth usually occur at intervals of from five to ten minutes. Shortly after the child is born, the woman is perfectly 'well,' and would appear normal to any visitor. The pains of normal labour take no serious toll of the woman, and usually the joy of the birth of a child more than outweighs any suffering she has had to endure. Every doctor would be more than willing to make all labour painless provided it could be done with safety. Clear-thinking obstetricians, however, are not willing to risk life for the sake of alleviating bearable pain.

The two safest places in which a woman can be confined are: (*a*) a large, efficient maternity hospital; (*b*) her own home. There can be no doubt that for people of moderate means the hospital offers many advantages. If the confinement is to take place at home the room in which it is to occur should be reasonably near the bathroom and lavatory, and not far from the kitchen or some place whence an unlimited supply of hot water can be obtained. It should be as bare of furniture as possible, and should contain one single bed, both sides of which are placed well away from the walls. Boards should be available ready to be placed under the mattress to prevent it from sagging during the actual delivery.

AFTER DELIVERY.

When the after-birth has come away, the patient should be put comfortably to bed, and given a cup of hot tea. She is likely to be tired, and may shiver after her efforts. Within a few hours she is likely to be quite well, and to differ from a normal woman only in two ways: (*a*) Her womb is very bulky, and will take time to return to its

proper size; (*b*) The place in the womb to which the after-birth was attached is a wound, and is liable to become infected.

In days gone by, large and uncomfortable binders were fastened round the abdomen shortly after delivery for the sake of the figure. The patient was, moreover, kept flat on her back for several weeks. The modern obstetrician has no use for binders, mainly because they prevent the patient from sitting upright and moving about in bed. Sitting up, if necessary with the feet over the side of the bed, promotes drainage from the uterus, and so helps to prevent infection. The best method of helping the figure to return to the normal is by exercises.

If a woman is healthy and strong, she can get up almost as early as she likes. Most women, however, need a rest from household duties, and it is as well for them to stop in bed for at least ten days.

When the baby is born the mother's breasts contain a fluid called colostrum; but the flow of milk is not usually established until the third day. It is interesting to note that colostrum is very much more concentrated than milk, and is said to contain a mild laxative. The baby should be put to the breast at six-hourly intervals by day until the milk arrives, and thereafter either three-hourly or four-hourly. If the baby weighs seven pounds or over, it is well to start him on four-hourly feeds, as it involves less strain on the mother and is better for the child.

Under no circumstances should the baby be fed at night. His little stomach needs a rest, and so also does his mother. It is usually possible, by the end of the first week, to train a baby to sleep through the night. If he cries by night he may be given some warm water without any sugar out of a bottle. During hot weather water should be given between feeds. Seeing that milk is rich in calcium and fats, it is well that the nursing mother should take at least two pints of milk a day, plenty of gruel, and at least a dessertspoonful of cod-liver oil.

CARE OF THE BREASTS.

The care of the breasts should commence early in pregnancy. The nipples should be carefully cleaned each day and gently pulled out. After the nipples are carefully dried a little spirit should be applied to harden the skin. Immediately before and after each feed the nipples should be cleansed with either plain water or a weak boracic solution. Some people paint the nipples with a mixture of glycerine and borax. Care of the breasts is important, because suckling causes moist friction, which tends to damage the skin of the nipples. Through these cracks infection may travel into the breast, causing inflammation and sometimes a breast abscess. Any milk left on the nipples easily ferments, and forms ideal food for bacteria. After the nipples are cleansed subsequent to nursing the baby, the breasts should be covered with a clean towel, so that the nipples do not come into contact with the clothes.

The womb should return to normality in about six weeks, when the lying-in period terminates. At this time it is advisable for the mother to be examined, to make sure that the womb has returned to its normal size and position, and to discover whether any damage has been done to the supports of the womb or the bladder.

THE BABY.

As soon as the cord is tied and cut, the infant should be wrapped in a warm blanket and kept in a safe place until the mother is comfortably settled. Before the baby is bathed he should be thoroughly examined to make sure that he is perfectly formed, and that the bowel opens properly on to the surface. It is also important to see whether the palate is normal. Frequently a cleft palate is not discovered for several days. A drop of 1% solution of silver nitrate should be instilled into each of the baby's eyes in case infection occurred during delivery. The cord should not be allowed to get wet in the bath, and should be dressed with powder and a piece of sterile lint kept in place with a small binder. The baby should be held over a basin or chamber-pot before being bathed. It is surprising how soon a baby can be trained to be clean.

A healthy baby should sleep most of the day and night, and simply wake up to feed. He cries: (*a*) because he is hungry; (*b*) because he is thirsty; (*c*) because a pin is sticking into him, or he is wet and uncomfortable; or (*d*) because he is 'naughty.' The last should never be assumed until all other explanations have been excluded.

The baby should be warmly but lightly clad, and the clothes should allow full freedom of movement. He should be put out in the fresh air as soon and for as long as possible. The dark brownish-black stools should have stopped by the fourth day. If not, a good big teaspoonful of castor oil should be given. Subsequently, the motions should be passed three or four times daily, be slightly formed, and of a canary-yellow colour. Any change in the stools is an indication that all is not well with baby. When at the breast the infant should be made to feed, and not be allowed to fall asleep or to swallow air. The stools and the scales afford the best criteria of the infant's condition.

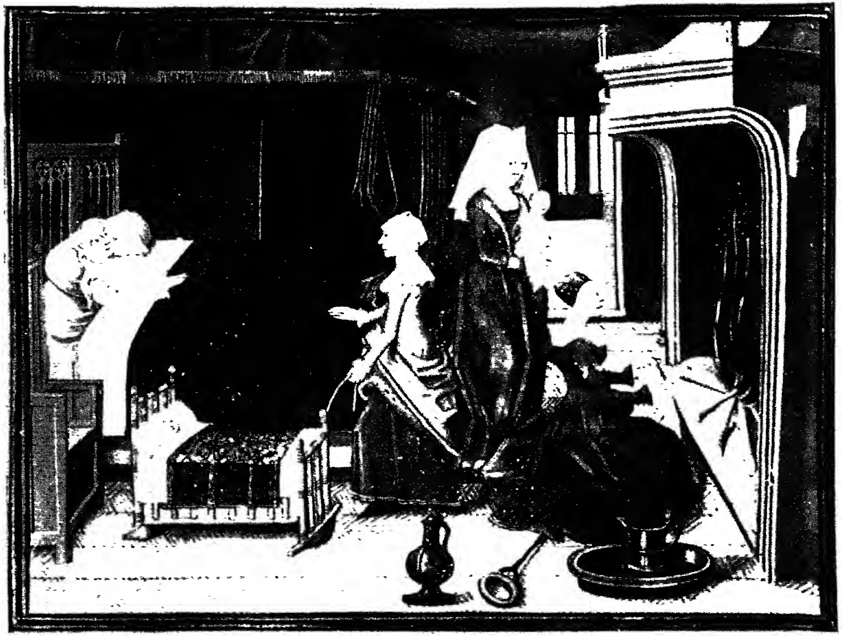
III—PARENTHOOD

Having a Child

That many people enter into marriage with but the vaguest idea of the problems and perplexities that they will meet is now a commonplace with which we are all familiar; but the position of those who become parents is less often held in question. Failure in the parental relationship, although it may have much more far-reaching effects than in the case of marriage, does not so often lead to legal action and public scandal, and thus the results are apt to pass with less notice. Nevertheless, it is through bad parentship that a great many of the evils of existence are handed from one generation to the next, and through good parentship, more than through anything else, that the foundations of happiness are laid.

When we think of the amount of training and education that is given to making us able civil servants, proficient bridge-players, or even tolerably attractive companions, it is strange that so little is done to assure our success as parents. Indeed parenthood—motherhood especially—is still largely looked upon as a province where Nature will teach all that needs to be known; and the sacredness of the maternal instinct remains something not to be tampered with lightly. Yet we know that, where other instincts are concerned, behaviour has to be modified by experience, by intelligent learning and thought, if they are to function successfully. So is it in parenthood. There is a great deal to learn, only unfortunately the need to learn it often only becomes apparent at a rather late stage in the proceedings.

When two people have a child, it is an event—to them—of extraordinary importance. They find themselves swept by emotions of unexpected power, just as the boy and girl at puberty or the man and woman first falling in love find in themselves feelings and impulses quite new to them. With the wife's pregnancy, and more still with the birth of the child, new instincts and emotions are aroused. Yet it is by no means true that a parental instinct makes its first appearance at this time. A strongly emotional attitude towards children and towards *having a child* has existed and has developed from very early years indeed, so that the parents, when their child is born, receive it in a way that is determined to quite a surprising extent by the past history of their own childhood and youth. The predominant feelings will be the pleasur-



By courtesy of the Trustees of the British Museum

A MATERNITY SCENE

Twins safely delivered. Fifteenth century

able ones of love and protectiveness, but more disturbing elements are likely to enter as well. For their own past has usually not been entirely smooth. They had perhaps, in their early years, to adapt themselves to the arrival of younger brothers and sisters. They have seen that the new baby, which was a thing to love and protect, was also something which drew upon their parents' attention and was a serious rival in the home. The love for it was not unmixed with jealousy. It is not difficult to find traces of this attitude persisting into adult life. The husband who does not feel somewhat out of it when his child is born is probably the exception rather than the rule. In some cases he may even feel so much out of it that his love for his wife and for his child is not strong enough to meet his distress, and the marriage suffers in consequence. The wife is far less likely to feel the child as a rival in the beginning, although this may happen later on. Yet her attitude may not be one of unmixed joy. In her own early years she will have had to cope with the desire to have and possess a child herself, a desire which is so strong in small girls. This may perhaps have led her always to take an interest in children, at first through play with dolls and care for her smaller playmates, and later by work where children are concerned. In this case it will have helped her very much in dealing with her own child. The desire may, on the other hand, have been so imperious and so discomforting that it was pushed aside altogether. Children were something that always belonged to her mother and not to her, so it was best to forget about them. She may thus have chosen a life in which she came very little into contact with them and appeared on the surface to be indifferent to them. Having a child herself will then change rather violently her former position and may lead to quite a number of difficulties. A very common way in which this rather *mixed* attitude towards the child shows itself is in over-fearfulness for his welfare. The mother is always anxious lest something dreadful should happen to him, and she worries at the least trifle. Her lack of confidence is not only a burden to herself but makes it difficult for the child to grow up freely and normally. Since her way of life has kept her largely away from children, inexperience and lack of knowledge in the practical handling of the child add to her problems.

These are only two of the many ways in which difficulties may become apparent with parenthood. For the most part, as is obvious, jealousies and antagonisms, fearfulness and anxiety, are far outweighed by the real love for the child. But this does not mean that we should shut our eyes to these negative aspects. Rather we should be prepared to recognize and face them if they appear, and should make sure that we have the means to control them.

Some things that help in such control are obvious. In the first

place the parents themselves must be happily married in the full sense of the word, finding adequate satisfaction for all their varying emotional needs in one another. Otherwise their attitude towards the child is almost sure to be an imperfect one. Quarrelling and estrangement may come, which are unquestionably harmful to him and exaggerate the less favourable aspects of the parental relationship. The tendency may develop to call upon the child for that affection and understanding which the husband or wife fails to supply. A bond may be established which sets a great strain upon him and makes difficult his progress into the world beyond the family. Both for the child's sake and for that of the parents, happy marriage is of the first importance. The notion that having a child may mend an unhappy marriage is a very dangerous one. In a few cases perhaps it may work, but in many others it will have the opposite effect; and the child will pay for the parents' experiment.

The parents' love for and confidence in each other as individuals must go hand in hand with confidence in each other as parents. It is not necessarily quite the same thing. A man may have the greatest faith in his wife's ability as, say, a novelist; but unless he also trusts her as a mother, they will bring up their children with difficulty. As an extreme of this lack of confidence we see the father who feels compelled to keep in touch with every detail of nursery management and still is not satisfied that things are being properly done; or the mother who, much as she loves and admires her husband, feels him to have so little understanding of children that she keeps them and their affairs to herself and leaves him very much a stranger to his own family. The co-operation of both parents is needed for the best upbringing of the children, and unless each trusts the other as a parent the stable and consistent environment which the child needs will rarely be produced.

Another way, of a practical kind, in which the difficulties of parenthood in the early stages may sometimes be diminished, especially where the mother is concerned, is through previous experience in handling children. Quite often nowadays one may hear the remark: 'You know, I never bathed a baby in my life until my own child was born.' This position, which arises fairly commonly under modern conditions, does not make the task of the young mother simple. We would suggest that every woman, before she has her first child, should find opportunities of dealing with children of as young an age as possible, preferably from birth upwards. This she should do under the guidance of someone who is skilled and experienced in their care. She should have practice in bathing, dressing, putting to sleep, and attending to all the needs of, a baby. In this way she will learn a great deal that is of practical importance and will gain that confidence and

sureness in handling the child that contribute so much to his sense of security and peace. Any errors that she may make in learning will not have the same ill-effects for the children in question as for her own child; in the first place because she will be an occasional rather than the chief attendant, and in the second place because, not being the mother, she and her doings will not have the same significance. This previous experience may do much to curtail anxiety that is likely to arise in dealing with a child of her own. That a woman should be expected to learn all the details of nursing, and to carry them out with assurance at a time when she is easily tired and perhaps readily perturbed after her confinement, is unfair both to her and the child. In ways of life where money is short and children numerous, this experience is usually gained naturally by helping relatives and friends; but where there are fewer children and more nurses this does not happen so readily. This preliminary experience is to be recommended whether the mother is to look after her child herself or to employ a nurse.

A great deal has been learnt in recent years about the ways in which children develop and about the things that help and hinder them. Some of these will be touched upon in the pages that follow. But if there is one thing that stands out above all our other discoveries it is the importance of the parents' attitude towards one another as well as towards the child. If the parents have love, confidence, and understanding with regard to one another, they have the best chance of developing such qualities towards and in their children. They can provide that security which is the first essential to good development and are in the best position to profit by their own experience, and that of others in the details of upbringing.

The New-born Child

The human child is born into the world in a condition of very great helplessness. A lamb or a calf is able, very soon after birth, to stagger to its feet and seek out its food. Rapidly it develops other accomplishments. But it is not so with the human. The baby needs after birth an environment which is not so very different from the womb from which he has come; or he will not be able to live at all. He needs, for example, an even, warm temperature, as he had when within his mother's body; he needs a restful place in which to spend the greater part of his time in sleeping; he needs careful support when he is nursed or carried; and he usually needs some protection against bright light and sudden loud noises. All this the careful mother can provide for him fairly easily, and by doing so she is doing much to lessen the shock of his new surroundings. But even though the peaceful conditions of the womb are to a certain extent continued after birth, life in many ways is very

different. Of paramount importance is the new way of feeding. Other things are new, too—breathing, for example. But this begins at birth and goes on all the time. The child does not have to do anything about it. But with food the matter is different. This does not happen automatically or go on all the time, and he has to do something about it. When he wakes and feels hungry, he cannot run to his mother as the calf does; but he can cry and then she will come—or perhaps she will not. It is just these situations, where we want something and may get it or may not, that arouse us to a state of acute consciousness, and bring all our faculties into play. So with the baby. His first great interest in life is his mother's breast. The feeding situation brings an easing of the tensions and distress of hunger, some of his most important discomforts; through lips and tongue he makes an actual, pleasurable contact with something that is outside and apart from himself, and through it he gains consolation and satisfaction. He has feelings of contact with the breast and the taste and touch and warmth of the milk in his mouth and throat, together with the appeasing of his hunger. And with this go feelings from other parts of his body produced by the position in which he is held and nursed. The sense of pleasure and comfort pervades the whole situation.

The importance of this early feeding must be stressed for many reasons. It is the main source of comfort to the baby, what he always seeks when anything feels wrong. It introduces the beginnings of knowledge of the outside world, and it is the first relationship with another human being—or perhaps rather a part of a human being—that he forms. It is a situation, moreover, that is not merely important during the first months of life and is afterwards quite blotted out. Probably no mental experience of any moment is ever quite blotted out. We have already seen that there are many factors in the situation and each takes on the pleasurable, satisfying feeling of the whole. Long after the child has ceased to feed from the breast he will find pleasure and satisfaction in being nursed. Even much older children, if they are ill or hurt, will sit in the laps of parents or other adults and snuggle up against them to be comforted, sometimes also sucking their thumbs. A good deal of this attitude is apparent still in the embraces of adults. What was so all-important for the baby remains important throughout life.

It is now clear that the feeding of the baby has to be taken very seriously. It can be said quite definitely that, for the sake of his mental no less than of his physical health, the mother should feed him herself if she possibly can. She should be able to feed him, too, with confidence and without worry, so that she can give him the greatest sense of security. This is something he needs fundamentally—as a back-

ground, as it were, to his future life. It is often said nowadays that women are too lazy or too pleasure-loving to feed their babies. Undoubtedly, this is frequently so; but it is perhaps worth pointing out that the objection quite often comes from the husband, who wishes his wife to be free to go about with him and resents the tie that breast-feeding imposes. This position is a particularly unfortunate one, since the mother needs the support of her husband in what she is doing if she is to have that assurance which helps a regular supply of milk and leads to the best handling of the child.

But there are cases where breast-feeding is not possible. Here every effort should be made to make the situation as like to that of breast-feeding as may be. The baby should be nursed in the arms and the mother should herself give the bottle, so that he may begin to learn something of her, her way of holding him, her voice and appearance, and learn this in connection with the satisfaction that he gains from the food. If the child is handed over to a nurse for his feeds, it is she who will become the figure typifying the pleasure and comfort of satisfaction. This is least harmful where the nurse occupies a permanent position in the household. What happens all too often, however, is that the mother decides that she will not breast-feed the baby, leaves him to the nurse, and then, since she does not feel inwardly very happy about it, begins to find the nurse at fault and finally dismisses her. It must be remembered that a nurse holds a very important position for the baby. Where she and not the mother feeds and looks after him, a change of nurses must be about as disturbing as a change of mothers. If a nurse is to be employed, obviously the greatest care should be taken at first in choosing one who has the right qualifications. But once the choice has been made every effort should be made to avoid a change.

It has been said that the feeding situation offers the main solace to the baby. It is what he seeks naturally when in distress. Obviously, the child cannot always be fed when he wishes it. This would often be bad for him and only add to his troubles. But there are ways in which some elements of the feeding situation can be used to give him the comfort without the food. One method, which we often see, is by giving the child a dummy to suck instead of the breast. In a way this certainly works. It calms and soothes him. But it is a bad way. Apart from drawbacks from the physical point of view, it is giving him his satisfaction in, as it were, a self-centred fashion. It is in no way advancing his knowledge of the outside world nor bringing him nearer to a knowledge and love of other people. We see the same technique adopted very readily by the child himself in sucking his own fingers or thumbs, an activity which may begin fairly soon after birth. Usually it is abandoned quite spontaneously, but where it is

continued into later years it indicates probably that the child is or has been unable to turn all that energy which was at first directed towards the mother's breast into more useful channels. Parents and nurses often become very much disturbed by this practice, which in itself seems to be a comparatively harmless one. The remedy must lie in offering the child other attractions, in aiming at fuller interests and happier family and social relationships, rather than in forbidding or preventing the habit. Usually far too much attention is turned to the symptom, and the anxiety that is felt is often quite unnecessary. The number of babies who suck their thumbs is very large. The number of schoolchildren who suck pens and pencils, and of adults who do the same sort of thing with pipes and cigarettes and cigars, is probably much larger still. And nothing very dreadful seems to happen to them. In any case, drawing attention to the symptom or introducing strict prohibitions is likely only to be harmful.

Sucking has the greatest attractions for the baby. By giving him a variety of objects, not to suck passively and monotonously as with the dummy, but rather to suck and bite and explore generally, this activity can be turned to good use.

So much, then, for the sucking. What of the other aspects of the feeding situation? An important one is the nursing in the arms which goes with the feeding. This is clearly pleasurable and comforting to the child, both in itself and through the association with the food. It is the good and natural way of consoling the child. For babies do need consolation; they have discomforts and distress for a number of reasons; and, apart from the attentions that their mothers and nurses can give, there are few ways of relieving them. They need to be loved in the quite primitive way of being nursed and fondled, and the mother usually needs to find expression for her own love in this way if she is to be free from anxiety. Young mothers nowadays are told that the baby should not be taken up whenever he cries, and so on. Most intelligent people have by now realized the truth that lies behind this advice, but some perhaps learn the lesson too well. When a mother sits miserably watching the clock in one room while her baby screams in another, we realize how easily a little science can make martyrs of the best of us. It may be said straight away that a natural and affectionate handling of the baby is perfectly consistent with regular feeding and sleeping times, and that where the mother has a happy relationship with her husband there will be little tendency to sentimentalize over the baby or treat him as a plaything. The important thing is to look upon him from the beginning as a human being. He comes into the world neither to be a comfort to his parents nor to be a specimen for the laboratory, but to be a child, and a child who will grow continuously to adulthood, developing his own interests and abilities and personality.

The Child and the Family

Feeding and sleeping in the beginning occupy the main part of the baby's life, but as time goes on the intervals of wakefulness grow longer and he has fuller opportunities of exploring his world. At first he attends to very little beyond the breast that feeds him, and this he knows mainly as something to be sucked. Soon, however, he becomes interested in other aspects of his mother; she is something to be seen and heard and touched as well, and these different aspects combine to make her a person for him. He becomes interested in other things that can be known, both in his own body and in objects that he can hold and, if possible, put to his mouth. For the lips remain the most natural means for learning about things for quite a long time. He takes great delight in the free movement of his limbs, in kicking and later in turning about and moving his whole body. As these interests and abilities show themselves, the child needs the means of developing them: opportunities for movement so that he may learn to move better and better, the kind of objects that he can explore with hand and eye and lips and, when his teeth begin to come, with these too. The growing interest in things around him affords him many new pleasures and leads the way to new knowledge and new achievement. At this stage the crying child can be made happy when given a new object to handle or the chance to kick and move freely. And through all this he learns.

So long as the child is unable to move himself about, his world remains a comparatively small one. As soon, however, as he can crawl, it enlarges tremendously. He can now go from place to place and takes huge delight in doing so. Space becomes of great importance to him. His desire to crawl from room to room of the house and round the garden is extremely strong. It represents his urge to practice his physical movement and his urge to find out things. The cottage where the child can 'follow his mother around' as she does her work is probably the paradise of this stage of childhood. This is a time when the child often shows discontent at confinement in the nursery, a fact which is not at all surprising. He has just learnt to move himself about, and finds a solidly fastened nursery-gate between himself and the world into which he is qualified to venture. It is not always easy to arrange, but the more the desire to roam can be satisfied the better. When the child can crawl, he is probably less eager than he was to test out new objects by carrying them to his mouth, although he will still use his mouth a great deal. He will explore endlessly with his hands, picking things up, fingering them, running his hands over the furniture, and so on. It is his way of finding out. 'Don't touch' to him is equivalent to 'don't learn,' and if we want him to learn we

have to put up with his own way of doing it. For many years touching remains of far more importance to the child, as a means of finding out, than it is to adults. It is for this reason that grown-ups, who do not understand children, usually find them unbearably meddlesome.

Already, when the normal weaning-time is reached, the child has a firmly established interest in the world around him. He has explored a great deal and found pleasure in a great deal over and above the feeding which was so all-important in the beginning. He knows his mother as a loving person and not only as a food-giver, and he knows his father and other people too. He now has much to compensate him for the loss of the mother's breast. Even new foods are not wholly unpleasant, for they give some chance of exercising the impulse to bite which is replacing that of sucking. He can soon use his hands, too, in feeding, and carry things to his mouth to new advantage. All encouragement should be given to the child to help to feed himself as soon as he shows that he wants to. The texture and appearance of foods soon come to be of importance to the child. In fact, the likes and dislikes of many children seem to be determined far more by these than by taste. They dislike a thing because it tastes 'slippery,' and will eat the most insipid mixtures if they are coloured pink and green and have a pattern on them. Usually until after puberty the child reacts to the appearance of food in a way that is different from the adult's.

We can now see the usefulness of the full period of breast-feeding, from the psychological point of view. It allows of weaning at a time when other interests and affections can do something to compensate for the loss that the child undergoes. The more interesting and friendly the world has been to him, the more confidence he has in his parents and his environment, the more easily is he likely to accept the new conditions.

In all that has been said about the child so far the mother has stood out as the principal figure. And this is true to fact. For in the first months the child's relationship to the mother is far closer than that to the father. He comes to know her earlier and better through her more frequent handling of him and through the intimate bond established through the feeding. Not only is his knowledge of her greater, but in the beginning he almost certainly loves her better.

All this is very obvious and very natural; but it may be rather hard for the father. It is a factor in parenthood that is apt to be overlooked and is well worth recognizing, for if it is recognized, there is no reason why it should prove a stumbling-block. Difficulties arise when the father does not for a moment admit that he feels excluded or jealous, yet finds that the necessity for regular feeding-times or the sight of napkins drying in the garden has an almost magical power of annoying him.

It is not long, however, before the father comes into his own, in a role that is of extreme importance for the child. He is well known long before the usual weaning-time and the child is developing an attitude to him which is somewhat different from that to the mother. Her first and, for a long time, foremost function is in feeding him, and in doing this she is supremely good and desirable. But at times she does not feed him when he wants it, and, at weaning, withholds the breast altogether. In this, she is very far from good; in fact, she is quite the reverse. Thus the passions that are directed towards her, especially when the question of weaning arises, are apt to be very conflicting. We may sometimes see this conflict expressed in the child's attitude towards the breast itself, for scratching and biting as well as sucking at the nipple are not at all uncommon.

Apart from matters connected with feeding, the mother, by the time weaning is reached, is probably exerting a not altogether welcome influence in other ways. For she will already be training the child in habits of cleanliness. Careful as she may be to praise success and avoid blame at failure, her attitude still cannot be quite that of ready acceptance of whatever the child does. She is beginning to discriminate his good actions from his bad actions. The child fairly clearly finds pleasurable relief in evacuation, but he learns now that his pleasure is not always reflected in his mother. He may find that what is good to him is bad to her, is met with reproach, or at any rate has a quite unenthusiastic reception. She will not always welcome his 'good' with signs of love and pleasure, and where she does not do so he very readily takes her to be hostile and frustrating.

The father, however, has probably not had quite the *supremely good or supremely bad* kind of relationship with the child that the mother has had, and thus, in a sense, may be an easier person to get on with. The building-up of a firm affection towards him is of first importance. Physical contact and satisfaction do not play the same part in it, but a common interest in achievement and the things of the world around enter into it very largely. While some mothers, at any rate, like babies so much that they would be happy always to keep their children at this stage, fathers usually have a strong wish for their children to advance, so that they may be able to share their interests and occupations. The love and interest of the father are of the greatest help to the child in overcoming the dependency of the early months.

Under normal circumstances, then, the mother is the first figure of importance for the child, although the father very soon enters into the picture. It will be worth while to look now to the child's attitudes towards people in the years that follow weaning. As a rule the details of these are extremely complex and hard to disentangle, but there are certain things about them that need to be kept in mind.

In the first place, the child's passions and affections during the early years are centred almost entirely within his own household. Mainly they are concentrated on the parents. The full strength of his feeling, which is very considerable, is directed towards them. As yet he knows little beyond the family and in general his knowledge is very small. His passions, too, have an intensity which is probably never equalled in after years. They are wholehearted. He goes all out. He is supremely happy when he is happy; his anger and rage are ungovernable; his terrors overwhelm him. We see how this happens. His feelings are strong; they are confined to comparatively few people; he lacks the knowledge and experience that would control them. When his parents are angry, everything he loves has turned against him. They are his world and they are angry. His terror and desolation are fairly complete. When his mother leaves him one day in strange surroundings, he feels left completely. His knowledge of past and future is extremely vague. It may be almost impossible to persuade a frightened child of two that his mother really will come back. It means nothing to him. She is gone, and that 's that. For young children live in the present to a most surprising extent. An older child knows when the mother goes away, even leaving him in unpleasant circumstances, that he will eventually see her again. The young child has to learn this. He really cannot look ahead so far, and so he feels left, and left absolutely.

The good factor in this way of living is that, once the child's attention is turned to something else, his mood changes fairly rapidly. It is far easier to console the child whose mother has departed by giving him something amusing to do than by trying to persuade him of the reality of her return.

This technique in dealing with him is useful in many ways. Pains from cuts and bruises and so on may cause real distress so long as the child's attention is directed towards them, yet vanish completely when he is led to think of something else. Incidentally, with regard to pain, it is worth remembering how large an addition of other feelings goes with it. One may see a child with a cut knee trot home quite happily, only to burst into tears at the first sight of the mother's concerned expression. Fear derived from the anxiety of others, or generated by the fuss made over the injury, readily combines with the pain to make the experience unduly distressing. How much, beyond pain, there is in our painful experiences can often be realized by watching a little girl having her hair done. Many children are extremely sensitive over this, and suffer even at the most careful combing. But give the child the comb herself, and she will often pull out large tangles by the roots with the remark: 'See, when I do it, it doesn't hurt.' We may compare, too, the gladness with which we suffer knocks in the interest

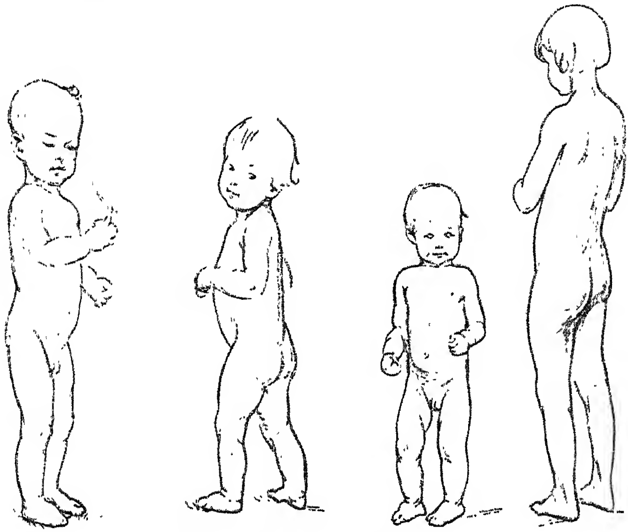
of sport with our feelings at the first touch of the dentist's drill. In dealing with small children it is of the utmost importance that their injuries, and for that matter their illnesses too, be treated in a matter-of-fact manner without the show of anxiety that will make the child himself fearful.

To return to the emotions of the very young child. We find in him a strong tendency to believe that whatever happens is happening to himself, is directed towards himself. This would seem to account in part for the overwhelming effect produced in him when the parents quarrel with one another. Most parents quarrel from time to time, and very many do so in front of their children. If they could find leisure to give an eye to the child who is present, they would quickly realize what a devastating process it is for him. To a large extent, anger of any sort is terrifying to him; anger between the parents is especially so because of the closeness of the child's bond with them.

When grown-up people love or like each other, we have a relationship something like this: 'I am I, you are you, and I like you.' But with the child it seems to be different, for there is very little 'I am I' about it. He has not any very clear notion of himself. He is only in process of building this up through his relationships with his parents and other people. He does not stand away from his world with any kind of detachment. He is building up his own personal attitude towards people and things only slowly, and is doing it largely through *being like*, now one, and now the other, of his parents. Perhaps it would be better to say through *feeling* himself, now one, and now the other, of them. In so far as he feels himself as one of the parents, quarrelling between them becomes for him an attack upon himself. When, as is probably the case, he has this feeling with regard to each of the parents, it becomes a strife within himself—something even more overwhelming.

The immediate moral of this would seem to be: 'Don't quarrel'; but there is more to be learnt from it than that. It points us to some of the features of the child's way of loving. This at first is modelled to a very great extent on the adult way, a fact that is not at all surprising when we remember what an important theme the parents are for the child and how closely he is actually associated with them. The child wants in the way of love quite a lot of what the parents have. We find the little girl behaving like a loving wife to her father and the little boy like a good husband to his mother. Sometimes these attitudes chop and change, the boy taking up a more passive and feminine position and the girl a more dominant one. Throughout the first years of childhood, we find children's wishes towards their parents extremely imperious. They want physical contacts. They want possession. They are capable of violent jealousy, not only with

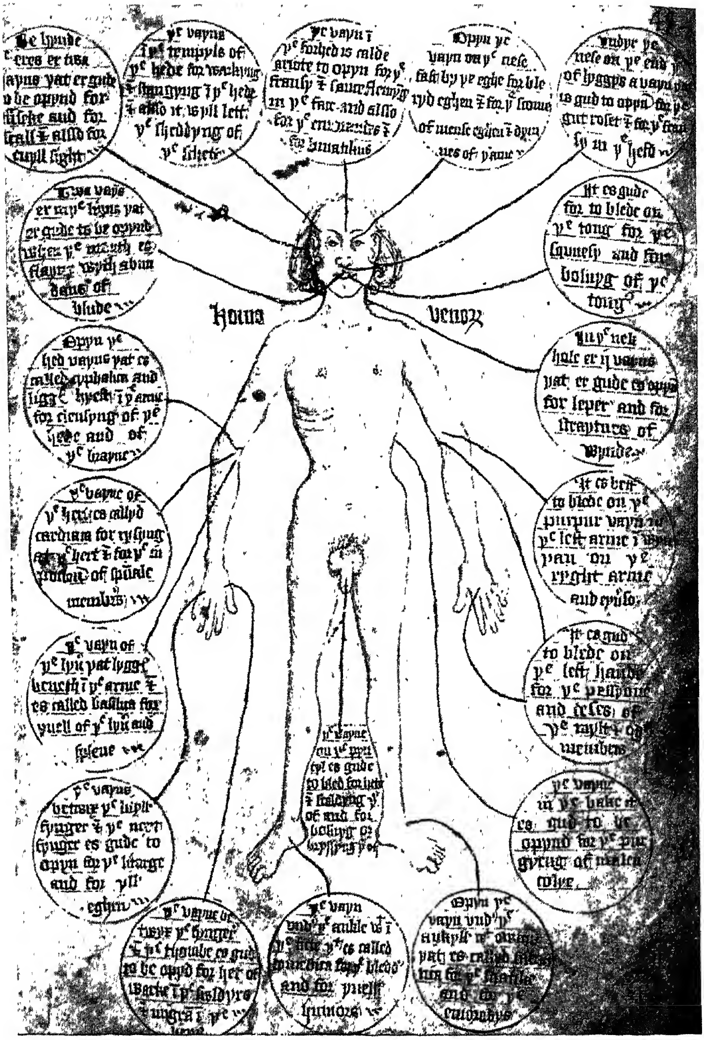
regard to brothers and sisters but with regard to the parents themselves. And they are fearful of the consequences of their passions. As a child of seven once expressed the matter to the writer: 'You know, it 's so difficult to love two people. It *feels* so much as if one of them must be angry.' In this we have a clue to a good many of the fiercer troubles of the early years. The child loves the parents; in his feelings and wishes he usurps the place now of one, now of the other of them, and



FROM INFANCY TO CHILDHOOD

feels that some sort of retribution is due to him for this, probably of the same crude kind that he himself would mete out to the usurper.

In dealing with children during the first years, we have to remember how much they are creatures of passion; how little there is to modify or ameliorate the passion; in fact, how generally vulnerable they are. We may consider the bearing of what has been said on the question of whether the child should sleep in the parents' room. Clearly where he does so his feelings are likely to be aroused to their full extent. There is the bed which he very definitely wants to occupy and he mustn't go into it. There is warmth and bodily nearness—the sort of things he once knew when his mother fed him, but had to give up—and they are all for other people and not for him. If his desires for all that is comforting and pleasurable are aroused, his jealousy and resentment at being kept out of it are aroused equally. Where, as sometimes happens, the parents have intercourse in the child's presence, the effect would seem to be greater still. For now he is beset not only



By courtesy of the Trustees of the British Museum

DIAGRAM SHOWING THE CORRECT PLACES FROM WHICH TO BLEED, UNDER THE DIRECTION OF HEAVENLY BODIES, ACCORDING TO THE DISEASE

From the Guild Book of the Barker Surgeons of York

with the feelings that occur when they show affection to one another and not to him, but with those feelings, too, that he experiences when they quarrel. For there are actually strong elements of fierceness in intercourse, and the effect of these is to arouse the same sort of terror as anger does. Moreover, the scene is so mysterious and so charged with emotion that it can be given no sort of place among ordinary happenings, and so is specially apt to produce in the child disturbances that are far-reaching and difficult to cope with.

Parents nowadays usually give the child his own room at an early age whenever it is possible, and this is certainly to be recommended. Very many people, however, make exceptions of special occasions, such as holidays. It is instructive to find that the same parents often complain that these holidays are really not very much fun. The child in question becomes so tiresome and impossible to manage.

If the child is capable of very mixed feelings of love and anger, fear and jealousy, where his parents are concerned, the same is true with regard to the brothers and sisters—especially the younger arrivals whom he sees taking the place he held. A good deal of the child's feelings on the subject are summed up in the saying of a little girl of 3½, an only child: 'Mummy, I do wish daddy would give us a baby. I 'd look after it and bath it and all that, and smack it when it was naughty.' We see how the child associates herself with the mother, 'give us a baby,' and how she is ready to take the mother's place and possess the baby herself. We also see how ready she is to vent on it her feelings of fierceness and superiority. Children often become profoundly disturbed at the birth of a younger child, and this disturbance may show itself in many ways: in destructiveness, in timidity and fearfulness, in aggressiveness towards other children, in restlessness, inability to sleep, night-terrors, masturbation, and so on, and so on. Some of this is probably inevitable, but care on the part of the parents can reduce it a great deal. In the first place, the mother and father can avoid hurting the child's feelings too violently by displays of affection towards the baby which leave the older child out in the cold. They must, in fact, make special efforts at this time to prove to him that their feelings towards him are unchanged. They can lessen the child's worry by avoiding any air of mystery. The child usually knows a great deal more than is realized about the mother's pregnancy, and it is far better to satisfy his curiosity on the subject than to allow him to elaborate his private suspicions. He needs to be taken into the parents' confidence in the matter, or resentment at being deceived will be added to his other troubles. He needs, too, to feel that he is co-operating—that the baby is something for him as well as for the parents. To go back to the little girl already quoted, she could not be allowed to bath a new-born baby; but there

are many ways in which an intelligent mother could satisfy and encourage her truly maternal feelings by letting her do small jobs in connection with the nursery. She could let her feel that to some extent the baby was for her. It is when the child feels: 'You have got the baby and I have not; you have got a baby and now you don't want me,' that the real difficulties arise.

During the first few years, then, children live very much within the family, and their desires are in a way very adult in character. They are very much concerned with family life and yet can never quite play the part they would like to play in it. They cannot be mothers and fathers at the age of four; they cannot take exclusive possession of parents whose affections have to be divided not only between one another but between the other children in the family. So this way of living eventually brings children up against reality with somewhat of a shock. Setting all his heart upon the father or mother, feeling himself into that position, does not bring the child all the good things that come to the parents. Rather it leads to a good deal of disappointment and frustration and often an almost intolerable mixture of love and anger.

It is really the rather intolerable character of the child's position when all his loves and hates and ambitions are centred within the family that drives him on to further development. But it is usually not easy for him, and we may find innumerable signs in normal children of the strain that they undergo. General unmanageableness, shyness, timidity, aggressiveness, destructiveness, enuresis, masturbation, fears, and night-terrors are all among the symptoms that show themselves frequently.

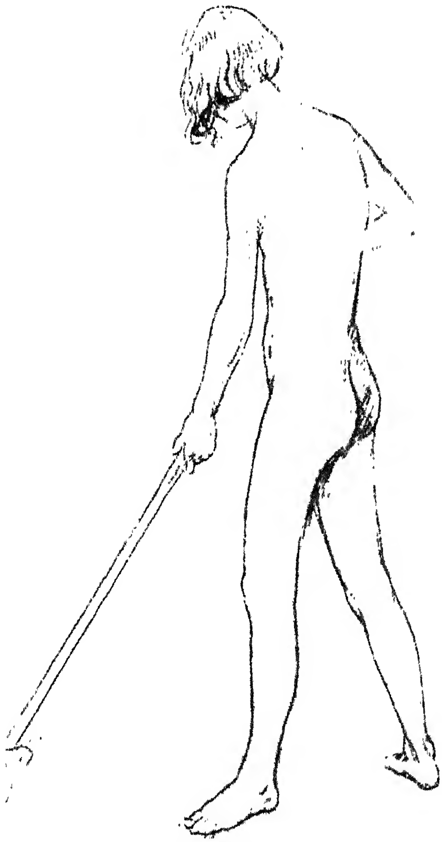
There are various ways in which the parents can help the child during these first difficult years. In the first place, they can let him feel the assurance of their affection, not only when he is good, but when he is naughty too. They can shield him from the effects of domestic conflicts and bear in mind that any steps which they can take to make their own lives happier and more peaceful will be the best medicine for him. Through understanding what is happening to him and the fairly common nature of his difficulties, their own resentment or anxiety over his behaviour will be likely to give place to a calmer and more tolerant attitude. And they can do much to facilitate the solutions of the problems towards which he himself is driving.

Making Friends

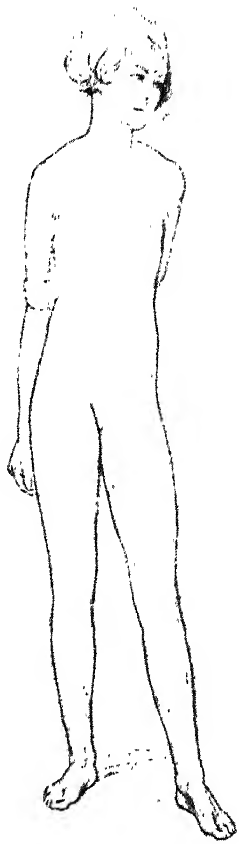
It may be well to look now to some of the ways in which the storm and stress of the early years are alleviated with further development. We may trace out one or two natural lines of growth which make for

an easing of the early difficulties accompanying an advance towards maturity. It is by facilitating such development that the parents can most easily help the child.

In the first place, with intellectual growth a great part of the energy



THE YOUNG GIRL (I)



THE YOUNG GIRL (II)

that formerly spent itself in emotional ways comes to be absorbed in the acquisition of knowledge and skill. Through this the child gains real mastery of his environment and actually approaches step by step towards the position of the adults whom he admires.

Play helps him extremely. Not only does he learn thus to better his actual achievement, but it is a means of expression that gives him an indirect satisfaction for many of the desires that are thwarted in reality.

for taking on new cults and generally getting away from the traditions and personnel of the family, there is small hope that development through adolescence to maturity will be achieved normally.

The parents play a great part in providing the necessary social environment for the child. They can look out for signs that the small child is becoming interested in other children and take steps to provide companionship. If parents followed the inclinations of the child rather than their own, many more children would find their way into nursery schools and classes. In most cases this is by far the most satisfactory way of helping the child, for thus he can meet other children of his own age on neutral ground. Where no such school is available, it may often be possible to arrange for a number of children to play together, although for many reasons this is not so satisfactory as the nursery school.

As time goes on companionship becomes more and more necessary. The need for it in later years is, however, more generally recognized, and, in any case, compulsory education normally does something towards it in the end. Usually it is only with delicate children and in comparatively small sections of society that governesses and tutors replace the school for long. It is during the early years that companionship is often lacking and its importance overlooked. When only children are allowed, as sometimes happens, to grow to be five and six years old with scarcely another child to play with, it is scarcely surprising that it should prove hard for them to get on with other people when they do meet them. They have had for so long to do without the friends they needed that they have been compelled to fall back on other less profitable or less comfortable satisfactions. We may find children in this position inventing companions, imaginary playmates, to take the place of the real ones. Often we find them shy or hostile or miserable when they first have real children to play with.

It is up to the parents, then, to see that the possibilities of companionship exist, and, if they wish to guide their children's development, they need to consider carefully the sort of people with whom they are to mix. For children very readily adopt the manners, tastes, and ideals of those around them, especially of those they admire. This is not just weakness or waywardness on their part. It is an essential feature of their development, of the building-up of their characters. It is unreasonable to find a child other children to play with and then be annoyed if he adopts their accents, habits, and mannerisms. He needs to do so; for it is a way of learning, of trying out new things, and it is an expression of the bond with his companions. One may sometimes hear an annoyed parent say to a child: 'Why must you always copy So-and-so? Why can't you be yourself?' This is a quite illogical demand. The child's self is a developing entity that grows

largely by absorbing and reproducing what he finds admirable in those around him. The part the parents can play is in so arranging life for the child that he has opportunities of making such friends as they themselves would not dislike. Thus, in choosing a school, the character of the children in it, and of the staff, must be a consideration of as great importance as the quality of the teaching.

The child will adopt a very great deal from the school and from the various other social groups that he enters. The parents need to let this happen. They can make things easier by choosing an environment which is not too unlike their own, one with which they are more or less in sympathy. Where there is a marked difference between the tradition of the home and that of the other groups that the child enters, they must be prepared to accept the results of it. They only hamper the child's development when they emphasize these differences or urge him to resist outside influences; for the child cannot follow only in his parents' footsteps and still remain healthy.

With the passage of the child into the wider society beyond the home, practical problems nearly always arise. The parents usually find things that they dislike in the school, however good it may be, and they usually disapprove of some or many of their children's friends. Where the objection is on purely reasonable grounds, it probably does the minimum of harm. The trouble is that most of us really want our children to be second editions—somewhat revised and improved—of ourselves, and our resentment at their departure from our own way of living only too readily takes on the guise of reasonableness.

It is often not easy to gauge the importance which the ways of new social groups have for the child. When a particular fashion in hair-slides or shoe-laces looms so large that any suggestion of departure from it is met with storms of protest, we have to remember that this may be a way of representing the solidarity of the new social group. In attempting to substitute a new kind of hair-slide, we may be attacking that solidarity, demanding of the little girl that she break away from her allegiance to her fellows and forfeit their support. For her it is not so small a matter as it appears. Our demand arouses the conflict between her feelings for her parents and her feelings for her fellows. Hence the storm. As parents we should be glad that the bond with the other children is strong, for this is clearly a factor in healthy growth.

With adolescence, more definitely sexual elements begin to enter into the child's friendships both with adults and with those of his own age, and this not only awakens his own scruples and conscience but adds very much to the parents' concern. On the whole it may be said that it is not the sexuality but the anxiety over it that is the greater danger to the child, and whatever the parents can do to bring him to

realize that this phase of his development is normal and acceptable is to the good.

At this time we may expect preferences for members of the opposite sex to come strikingly to the fore. However, with a system of segregation in schools and colleges such as we have in England, the most frequent and regular companions of the maturing individual are often members of the same sex. The result is that these constitute the readiest objects for the now powerfully reinforced affections. Whether this is altogether a good thing is open to question. But with such a system we cannot be surprised if more or less passionate homo-sexual attachments frequently develop. Where they are felt to be harmful, a remedy is to be sought in fuller opportunities for hetero-sexual companionship rather than in prohibitions and moralizing. Ordinarily the boy or girl leaves this phase spontaneously and naturally as the sexual impulse reaches its full strength.

Through the enlarging of the social circle, then, the feelings that were at first concentrated within the family are more widely distributed, giving some measure of relief to the tensions of the early years, and making it possible finally for the individual to adopt an adult way of living. The parents need to give their help to this social development and to be prepared to relinquish their children more and more to the outside world. It is the best, in fact the only, means of securing a real friendship with them. The parents who live and have their being entirely in their children and feel strongly possessive about them are not always the most helpful ones. Prized as their devotion may be by the child, it may yet make it difficult for him to establish his own position. This type of relationship arises perhaps most readily where one parent dies; but it also often arises when the parents find little satisfaction for their love in one another. The situation may be relieved by increased interests and opportunities for work so that they need to depend less on their children; or through wider human companionship. The parent who feels, or says to a child: 'Darling, you are all I have in the world,' puts a responsibility upon him which he should not be asked to bear. Children need more or less contented parents if they are to grow up as happy and well-poised individuals.

Learning

Social relationships provide one way in which the child's energies are absorbed and redirected. Intellectual development provides another. As the child grows, much of the energy that spent itself in emotional ways is taken up with learning, with finding out and acquiring skill in doing. Learning begins at birth with the first stimulation of the

sense organs and the first movements. When the child can handle an object, can touch a thing that he looks at and carry it to his mouth, he has already learnt quite a lot. Gradually, with practice and the strengthening of his muscles, he learns not only control of hand and eye but of his whole body. He learns to stand and walk, and the parents greet the accomplishment with great triumph. Usually they take pains to help the child in this respect. However, when the child has learnt to walk, he is still only in the early stages of acquiring bodily control. His balance is still poor, and it is many years before it is perfected. He has to learn to run after he can walk and he needs space for this and freedom to practise it. A small child does not easily walk quietly and steadily. Walking, running, stopping altogether, and then going on again are his natural way of progression. He needs many opportunities for acquiring balance, and for this purpose things to climb over are most desirable. A variety of apparatus exists to meet these needs of children—steps, boxes, jungle-gyms, etc.—and where there is plenty of space and no need for economy it can be very useful. Nursery schools are particularly fortunate in being able to provide material of this kind for the children who attend them. However, there is no point in cramming a small nursery with expensive aids to development and so reducing the necessary space for movement. Often all the needed opportunities can be given by relaxing the rules about not putting one's feet on the furniture. An old sofa gives excellent climbing, and, although the springs certainly suffer, the child gains.

And it is not so very long before he grows too big to be interested in the sofa and prefers climbing trees. Wherever there are trees to be climbed, children—both boys and girls—should be allowed to climb them. They are an ideal form of apparatus, presenting endless variety and calling for ingenuity and control of the whole body. The wise parent devises clothes that are suited to the purpose and does not complain of the ensuing dirt and untidiness. Children, being on the whole less vain than adults, have not the same incentive to look clean and well-kempt. To them climbing trees is far more important, and it is quite right that it should be so.

Swings are a form of apparatus supplied fairly commonly to the child, and they give very great pleasure. Perhaps even better is the swinging bar, or trapeze. If, instead of the seat of the swing, a bar be fixed at about the height of the child's shoulders, it becomes susceptible of many more uses. The child can sit on it and swing, hang by its knees and swing, and practise acrobatics of various kinds. Skilful children from about five years old onwards are usually really interested in this, and they learn far more from it than from the ordinary swing. Sometimes ropes for climbing can also be fixed and they are

an additional boon. Where there is no swing, a bar for hanging on and turning somersaults can sometimes be devised.

These forms of exercise, climbing trees, playing on bars and ropes, etc., are particularly good, because in them the child exercises not only the lower limbs but also the arms and trunk. How intent and absorbed children become in hanging on to things, pulling up with their arms, and climbing on to them, can be seen by watching any group of children with a suitable railing. To the children who are not allowed to play on railings some substitute needs to be given. When the child reaches school, the gymnasium provides excellent opportunities; but in most schools this occurs as a more or less isolated event. It needs supplementing.

We have to remember that the child is by no means as content with just going for walks as are older people. He needs more varied movement and more imaginative content to his activities, and he supports the fatigue of continued exercise of one type badly. Thus dancing, climbing, and the various forms of gymnastic exercises all appeal to him, and interest in these may appear very early. It is up to the parents to watch for the beginnings of such interest and to use what means they have to cater for it as soon as it appears. It is impossible to lay down fixed rules, or mark out definite stages of development in these respects. There is only one rule to follow, and this applies to dealings with the child throughout its whole mental development. The parents must follow the child, must watch for the interests that develop, and supply the necessary means for meeting them as they develop. To put a child off with: 'You 'll have to wait for that until you are older,' should be avoided wherever possible. He will learn far better if he learns when and as he wants to, and he will not have that sense of the thing being forbidden which so often makes later learning difficult. This applies to the acquisition of knowledge equally with that of skill. In having the opportunity of watching the growth of the individual child, the parents as educators have an enormous advantage over the school. The teacher can usually only give what seems best for the group and this is probably not ideal for any one child. The parents can know and supply the needs of the individual, and the help that they thus give is an essential supplement to the work of the school.

Skill in finer and more precise movements grows as the child develops. To begin with, this is very small. We can see the young child using his whole hand to grasp with, then learning to hold things with thumb and finger. His early attempts at drawing are often made from the shoulder, and only gradually does the activity become confined to smaller groups of muscles. We see, then, that play material must be adjusted to these capacities. We cannot expect the very young

child to deal with delicate and intricate things. He needs good-sized pencils and brushes and large sheets of paper for drawing and painting. Children build with large bricks before they do so with smaller ones, and enjoy making things out of canvas and coarse wool when finer sewing would still be impossible for them. We may waste much money and labour in procuring material which is too advanced for some children, and we may insult another child unforgivably by offering that which is appropriate to an earlier stage of development.

Individuals appear to differ very much in their ability to do things with their hands. These differences are in part probably innate, but parents can help the apparently clumsy child a great deal by giving him confidence, by trusting to his success and not stressing his failure, and by giving him the sort of material that they see he can deal with. Sometimes the clumsiness of the child may be on a par with that of the housemaid who inadvertently smashes something every time her mistress scolds her; it may perhaps indicate a real, though quite unrecognized, desire to smash up all that he loathes; and here it is a happier adjustment to his environment generally that is called for.

Learning to do things with hands and limbs and body continues throughout the child's life, and he spends a great deal of his energy in this. Only the very dull or ill or unhappy child sits quietly doing nothing. Healthy, intelligent children need a great deal to do, and we must not be surprised if they sometimes tire rather quickly of one activity and go on to something else. They will concentrate for quite long periods on things that interest them, but they will not always continue to find pleasure in something they have mastered. To curb the child's activity, to expect him to be quiet and passive, or remain unoccupied whenever it suits adult convenience, is to hamper his growth and to throw him back on to ways of living that are ultimately harmful to him.

The beginning of speech is as striking a landmark in development as the beginning of walking. As walking opens up for the child a much wider environment, speech offers a means of communication and self-expression which is far more efficient than any he has known before. Usually the child of a year has one or two words that he uses and he understands a very great deal more. By two years old, he may already have a vocabulary of several hundred words. Children, however—even those who are equally intelligent—differ very much in this matter. We may sometimes find quite bright children who do not begin to talk until after two. Unless there are other signs of backwardness, the parents need not worry overmuch about lateness in talking. They can make sure that the child is not growing up in too silent surroundings, and that such attempts at speech as he makes are received simply and without fuss and commotion that will embarrass him. They

may try to procure child companions for him if there are not already elder brothers and sisters, since there is a certain amount of evidence to show that this helps in the acquisition of language. Beyond this they cannot do very much.

A word may be said here about the use of *baby-talk* by adults, that medley of made-up and distorted words that is so often meted out to young children. There is no reason to suppose that this is of any real help. Although it may lead to increase of vocabulary in the beginning, it means a good deal of unlearning and relearning later on. It must, too, be discouraging for the child to find out that what he has acquired so arduously is only an inferior brand of language kept peculiarly for himself. Children learn very readily from simple, normal speech and gain far more confidence from this than from learning a language that marks them out as babies.

The parent or nurse who persists in the use of baby-talk to a child probably does really prefer him as a baby and would like to keep him such. This attitude is one that makes growing up very difficult.

Language gives the child a new means of mastering his experience. It is the same with all of us. When we can put a thing into words it is more or less all right. We say we can't find words for it when the matter is really overwhelming. It would seem, then, that the more the child's vital and important interests come to expression in words the better for him. To tell a child: 'No, we mustn't talk about that,' is to prohibit this means of dealing with the situation. If he may not talk about it, he may at least worry about it, and this, in one way or another, is probably what he does.

It may be well now to consider one or two of the more important interests of the child, particularly those with which parents sometimes find it difficult to deal. One about which much discussion has lately centred is the interest in reproduction. This interest is certainly amongst the most absorbing for the child. It is probably strongly developed in all normal children by four or five years of age, although it may not come to direct expression in words. There is small doubt that, when the child is wondering about how babies are born, about the differences between boys and girls and men and women and about what the mother and father do in order to have a child, it is far better for him to communicate his thoughts and receive information on the real facts than to continue to worry on his own. Having the matter in words does something to relieve the sense of mystery which is so extremely burdensome and allows the child to feel that knowledge, whether on this subject or any other, is not forbidden fruit. But with the best will in the world, parents may find the matter difficult.

A good deal of the difficulty is often already established during

earlier years. For before the child shows open interest in birth and sexuality he usually shows interest in the excretory functions of the body and the actual excrement which he himself produces. Curiosity with regard to this is perfectly natural. By accepting it and satisfying it, by giving explanations, where they are asked for, of how the excrements are formed and of the process of digestion, the parents are beginning to show the child that the interior of the body and its functions are not entirely unintelligible. The child would seem to be very much concerned with what is inside the body. He knows that food goes into it. He knows that when he cuts himself blood comes out of it. He knows that the excrements come out of it. These things he can learn from his own experience, but they are inadequate data to go on. Whevever the parents observe this curiosity, they should do their best to furnish the true explanations. We may find intelligent children acquiring quite an extensive knowledge of the workings of the body in this way, and in doing so they are turning to useful ends energy that would otherwise be used up in being painfully concerned about the matter without any kind of profit.

As important as, or more important than, the actual giving of information is the parents' attitude. Where they have shown much harshness or disgust or distress at his failures in learning habits of cleanliness, the child is likely to treat the excretory processes as matters where he can hope for nothing but hostility from adults. He will not then readily express his curiosity. Where he does so and is met with prohibitions, where the parents are shocked or embarrassed, he will receive yet another set-back in his efforts to establish communication with his parents on what is, to him, a very important matter.

Where there is failure to reach a tolerant and unembarrassed attitude over excrements, there is likely to be failure over the question of birth and parenthood. For the two matters are very closely connected, both in the child's mind and the adult's. The shame or embarrassment attending the one is likely to spread to the other. Where, however, the earlier curiosity has been satisfied, where the child trusts his parents to accept his interests, and not reject them as abnormal and unpleasant, he will probably readily come forward with questions as to how babies come to be born. When he does so these questions should be answered in the same way as any others that he asks. His asking them is a sign of healthy development. It shows that he trusts his parents and is seeking to find some solution of his problems through communication and increase of knowledge.

The ease and success with which parents answer their children's inquiries will depend to quite a large extent upon how far they themselves are in the habit of discussing the matters in question. For one thing, often a considerable knowledge of anatomy, physiology, and

a child's questions as they are asked. Where they are not asked, it is probably unwise to press information on the child. The rather roundabout method, via plants and animals, may be very useful here. It is fairly well established that absence of questioning in ordinarily intelligent children does not indicate absence of curiosity. Often it is a sign that the concern is so great that conscious formulation and expression are prevented. Considerable care needs to be shown in dealing with children of this type.

The interest in reproduction has been dealt with at some length, partly because of its great practical importance in the bringing-up of children, partly because of its value from the point of view of understanding them. Watching the growth of this interest in our children gives us many clues to the puzzle of their development. Among other things, it allows us to glimpse the continuity in development from infancy to maturity. Possibly some will feel that the countenancing of such interests means good-bye to the age of innocence. But is that not perhaps a relief? Is it not preferable to feel that, after all, children are human beings like ourselves; that we do not need perpetually to be protecting their 'innocence' from our own implied lack of it? Another thing which we see very clearly in this interest is the fusion of emotional and intellectual trends. The child's powerful emotions supply the driving-power for his learning. We may see the same thing happening with many other of children's interests. Parents can observe it for themselves; space does not allow of following the matter further here.

Conclusion

We have seen how a great part of the child's energies are taken up in learning and in making friends. But he does not get all that he wants in this way. The turbulence of the early years—for they are turbulent: often outwardly so, inwardly always—is not entirely allayed. Many desires remain which are unfulfilled; many fears have still to be held at bay. In dealing with these, play helps the child very much. It is a natural safety-valve, a means by which he may discharge his impulses—whether of love, aggression, or what not—without the guilt and punishment that would follow them in reality, a way of achieving the longed-for and impossible. Disguised as the matron of a hospital, an engine-driver, or a duchess, a host of things becomes possible. In play the child may enjoy power, authority, wealth, may love, maim, or destroy, all with equal impunity. Often we may see the difficulties of the child's own life clearly dramatized in his play. In this he finds pleasure and relief. In some ways play resembles day-dreaming, but

it has many advantages over it. The satisfaction of play is achieved through speech and action and there is a constant calling upon reality. The imaginary hospital is filled up with oddments of pots and pans which constitute nursing and medical apparatus, often of a highly technical kind. The packing-case has all sorts of gadgets that make it very much more like a real fire-engine. Through play the child not only masters a great deal of his own inner conflict, but he learns a great deal that is useful and important. Neither parents nor schools can afford to overlook the value of play. It is all-important. We sometimes hear complaints that a child does not want to work; all he thinks about is play; children who do not play are a much more serious problem. Grown-ups do well to leave children alone as much as possible in their imaginative games. They need to arrange for the companionship perhaps, see to it that there are children well-suited to one another to play together, that there is ample space and some material to use. Beyond that, they can largely leave them to it. The chief virtue of the adult in this respect is non-interference—a virtue not easily acquired.

The attempt has been made to indicate some of the conditions that make for favourable development. But even given the best conditions growing-up is not without its difficulties. The child never gets entirely what he wants. No stage of life is quite without its fears, hatreds, and unsatisfied loves. We forget, of course, these difficulties. We think they vanish completely; but do they? It seems that the human mind preserves in an extraordinary way whatever is of emotional importance. However well our lives may be arranged, much of our energy seems to remain tied up with these forgotten troubles—tied up in such a way that, to use a very loose expression, we cannot control it but it can control us. We see it making its appearance sometimes in curious ways, in unaccountable fears, in habits that are annoying to other people and even to ourselves but which somehow make the world seem a little safer, in twists and kinks of character, and so on. We see ample evidence of this tied energy striving towards expression in the life of any boy or girl. There are few children who do not at some time or another have nightmares or night-terrors, who do not feel compelled towards masturbation, become absorbed in day-dreaming, give way to behaviour which is unreasonable and objectionable even to themselves. Where these difficulties are exceptionally great the cure must lie in releasing and bringing under control the energies that determine them, a matter involving a special and highly skilled medical technique. In these pages the attempt has been made to show some of the ways in which a healthy environment, both social and material, may lessen the chances of their arising.

IV—BIRTH-CONTROL

THE object of birth-control is to permit normal sexual relations in marriage without the risk of an unwanted pregnancy. It aims at perventing conception—the union of the sperm cell of the father with the ovum (egg) of the mother—and the various chemical and mechanical agents used for this purpose are known as contraceptives. There is no *absolutely* reliable method of birth-control, but medically approved modern methods are almost certainly harmless, and are reasonably reliable when properly carried out. It must be emphasized, however, that each case should be considered individually by a doctor, who will select the most suitable method and who will instruct the patient in the correct use of that method. A method which is suitable in one case may be quite useless or harmful in another, and a medical examination is essential for determining the correct type and size of any contraceptive appliance. Many wives have discovered, at the cost of an unwanted pregnancy, that it is quite futile to buy appliances from chemists or 'rubber shops,' or by post from the manufacturers on their recommendation. Advertisements of contraceptives usually make unjustifiable claims for the success and suitability of the advertiser's own particular products, and it is unwise to use either a soluble chemical contraceptive or a mechanical appliance except on the advice of a doctor. If the particular contraceptive is advertised as being *absolutely* reliable, or the *only* reliable product of its kind, there is all the more reason to distrust it. There have been failures with every known kind of contraceptive. For anything like a 99% prospect of success with an assurance of harmlessness, the contraceptive method adopted should be prescribed by a properly qualified doctor, who is experienced in the technique of contraception.

Some people confuse birth-control with abortion. Birth-control aims at the prevention of creating a new life; abortion, on the other hand, is the destruction of life. It is well known by doctors, nurses, midwives, and social workers that attempts to procure abortion, successful and unsuccessful, are tragically common, especially in the overcrowded homes of the poor. Desperate mothers risk serious damage to health, and even death, not once, but many times, in their determined efforts to prevent an increase in their family. Abortion, except when carried out by qualified doctors for medical reasons, is a criminal offence: the operation requires the same care and skill as any other abdominal operation. Yet these poor women, when their own attempts have failed, sometimes cripple themselves financially to pay the fee of some

unqualified illegal abortionist who is no more skilled to perform such a delicate and dangerous operation than is a travelling tinker. Birth-control, properly practised, offers a harmless alternative to the illegal, harmful, and dangerous practice of abortion.

The size of the present-day family of the middle and upper classes, compared with that of the families of Victorian times, shows that birth-control is now widely practised by these classes. It is but social justice that a knowledge of proper methods of birth-control shall be made equally available for the poor, among whom there is the greater need for the limitation of their families. Birth-control should not mean a childless home except in those cases in which, for medical or economic reasons, the birth of children would be unjustified. The ideal family will, of course, vary with the health of the parents and the economic conditions of the home. If the race is not to suffer, healthy parents of good stock should have as many children as they are able to maintain properly, without sacrificing the health of the mother. Birth-control will, even in these cases, be advisable in order to space the births of the children, and to permit normal sex relations when the family has been completed.

There are various medical reasons why, in some cases, pregnancy should be postponed, either temporarily or permanently. These include hereditary mental or physical disease in the family of husband or wife; such diseases as insanity, mental defectiveness, epilepsy, and tuberculosis in either partner, and in the wife certain diseases of the heart and kidneys, cancer, diabetes, and exophthalmic goitre. Such physical deformities as hare-lip, cleft palate, and club-foot are known to be hereditary. It is well to discuss the matter with the family doctor before deciding that, for medical reasons, parenthood must be postponed or permanently avoided. Modern medical science can now do a great deal to overcome physical difficulties which in former generations made a difficult labour inevitable or even endangered the life of mother and child. In many cases abnormal smallness of the bony part of the birth canal can now be overcome by inducing labour before full term, so that the baby's head during birth is smaller and softer and more easily moulded; or by performing the operation of Caesarean section, by means of which the baby is removed through an incision of the abdominal wall. A denial of parenthood can be a real tragedy, and may even wreck a marriage; it should not be accepted without very full investigation of the circumstances by a doctor.

For the intelligent adoption of any method of birth-control, it is well to understand clearly the problem involved. To under-estimate the difficulties may lead to failure through carelessness or inattention to detail. There is no foolproof reliable method of preventing pregnancy; forethought, self-sacrifice, and willingness to take trouble, are essential.

Let us first consider briefly the conditions essential for conception. Conception occurs when one of the millions of sperm-cells in the semen (the fluid ejaculated by the husband at the moment of orgasm) succeeds in coming into contact with the ovum (egg-cell) in the tube leading from the ovary to the womb. Normally, one ovum is released from one of the ovaries once a month, and this cell remains alive and capable of being fertilized only for a short time—possibly several hours, and certainly not more than a few days. It is obvious, then, that conception can occur only during the period when the living ovum is present in the tube, and that coitus at other times cannot result in pregnancy. If we knew definitely the times when the ovum is present in the tube, and how long the sperm-cells of the husband can remain alive within the genital tract of the wife, we should be able to calculate with certainty the period during the menstrual cycle when conception is impossible. Restriction of intercourse to this period would then be a reliable method of birth-control. That there is such a 'safe period' in the case of every woman is undoubted; but the fact remains that we cannot at present define this period with certainty. The sperm-cells deposited within the vagina have the power of independent movement: they can swim along the moist lining of the female genital passages, and they are attracted towards the tubes leading from the womb to the ovaries. The womb opens into the upper end of the vagina, and once any sperms succeed in penetrating this opening they are secure from the action of any contraceptives within the vagina. It must be emphasized that the sperms can remain alive and almost certainly retain their power of movement for some hours within the vagina when the conditions are favourable. Any method of birth-control which—as it should—permits normal coitus, with ejaculation of semen before withdrawal of the penis from the vagina, must aim at preventing the sperms from entering the womb, and subsequently at destroying or removing the sperms. The most reliable methods of birth-control therefore combine the use of a mechanical appliance to prevent contact of the semen with the neck of the womb, and a chemical to destroy or immobilize the sperm-cells. If any semen containing living motile sperms remains within the vagina after the mechanical obstacle has been removed, then conception may result if even one of the sperms consequently succeeds in entering the womb.

Harmful and Unreliable Methods of Contraception

Some methods of birth-control are to be condemned because they are unreliable, or harmful, or both: and certain popular ideas of 'safe periods' lead to unwanted pregnancies. Such methods and ideas include the following:

(*a*) '*Withdrawal*' (*coitus interruptus*), known popularly as 'being careful.' This is unsatisfactory for two reasons: its unreliability, and its possible harmfulness. It is probably the least reliable method of all, since recent investigations of many hundreds of cases have revealed that large families are produced in spite of 'withdrawal' on each occasion of intercourse. Even if the husband succeeds in removing the penis from the vagina before the ejaculation of semen, there is yet some danger of an unwanted pregnancy owing to the possible presence of some sperms in the moisture which is produced from the penis before ejaculation, moisture which may be present before penetration. Moreover, the regular use of this method, over a period, may produce definite mental and physical injury. If the husband cannot delay withdrawal until his wife has reached her climax (orgasm), she is left tense and unsatisfied, and this may lead to insomnia, mental depression, 'nerviness,' and dislike of the sex relationship if the unnatural strain is frequently repeated. In addition, she may develop certain physical symptoms as a result of the repeated prolonged congestion of her sex organs. The effects on the husband vary. Undoubtedly there are men who practice 'withdrawal' with no apparent ill-effects, but in the majority of cases neurasthenic symptoms develop sooner or later. The husband may lose his self-confidence, become worried over trifles, and develop a state of anxiety so that he broods over possible calamities, and even dreads the postman's knock. He, too, may become afflicted with sleeplessness and irritability. Opinions as to the harmfulness or harmlessness of *coitus interruptus*, however, vary widely.

(*b*) *Lactation*. The activity of the breast glands in producing milk is popularly believed to prevent conception, and many of those who regard the period when the baby is on the breast as free from the risk of conception and consequently neglect to practise birth-control during this time find at the cost of another pregnancy that a woman may become pregnant while she is breast-feeding, even though she has not yet resumed menstruation.

(*c*) *The so-called 'safe period.'* Reliance on the 'safe period' has proved in practice most unreliable; but many 'failures' may be due to the popularly held but erroneous idea that the mid-menstrual fortnight is the sterile period. For those women with a regular twenty-eight day menstrual cycle, the period when they are least likely to conceive is during the ten days immediately preceeding a menstrual period. Only experience can prove whether this period is indeed absolutely sterile in any particular case, and the price of the experience may be an unwanted pregnancy. Records show that conception has occurred at all stages of the menstrual cycle. There is no way at present known of determining an absolute safe period in any particular case, except, of course, the impracticable one of trial.

(*d*) *Appliances which penetrate into the neck of the womb or which are placed completely within the cavity of the womb.* These mechanical contraceptives are, in the opinion of the writer, exceedingly dangerous, and the use of such appliances should be avoided. Examples of these pernicious contraceptives are the 'wish-bone' gold stem pessary, which is placed in the upper end of the vagina with the stem penetrating the neck of the womb and is left in position for months at a time; and the silver ring, which is actually inserted into the cavity of the womb and left in position for a year or longer. Serious infections causing inflammation of the womb and surrounding structures have resulted from the use of such appliances, and operative treatment including removal of the womb and tubes have become necessary in some cases. No mechanical appliance, even when it does not penetrate the neck of the womb, should be left in position for longer than about twelve hours.

(*e*) *'Holding back,' or the effort to prevent orgasm by the wife.* Some wives lead a mutilated sex life because of the erroneous idea that orgasm in the wife is essential for conception. Such an idea is quite untrue. Some very fertile women, who have had large families, have rarely or never experienced orgasm.

Classification of Methods

Methods of birth-control which are medically approved when used in suitable cases can be classified as follows:

(1) *Used by the husband.*

The *sheath* or *condom*, known popularly as the 'French letter.' This is worn over the penis during sexual intercourse to prevent escape of semen into the vagina.

(2) *Used by the wife.*

Mechanical appliances: *rubber pessaries, sponges, and plugs.* These cover the neck of the womb, and their object is to block the opening into the womb and so to prevent the entry of sperms.

Chemicals: *suppositories* (soluble pessaries), *tablets, jellies, and medicated douches.* These are used to destroy the sperms which have been deposited within the vagina. They should be used in combination with a mechanical barrier, so that when the latter is removed and the entrance to the womb is thus uncovered, there shall be no living sperms left within the vagina.

THE MALE SHEATH OR CONDOM.

When properly used this is one of the most reliable of contraceptives, and is perfectly harmless. The popular notion that it may cause 'consumption' or 'nervous diseases' in the husband is quite untrue.

The use of the sheath is the ideal method during the honeymoon and early weeks of marriage. There are two kinds of sheaths—those to be used once only and then thrown away, and washable sheaths that may be used several times. Rubber, of which most sheaths are made, tends to perish even when not in use, and it is therefore important that *a sheath should be tested before use.* To test a sheath it should be unrolled, and then inflated by blowing into it; or be partly filled with water and compressed from above. The presence of even a tiny hole can thus be detected; and it must be remembered that a hole so small as to admit only the point of a needle may allow exit to several thousands of sperms. Some manufacturers of sheaths are now dating their products, as a means of ensuring that old stock, the defects of which may not be apparent before use, shall not be sold. Most sheaths are sold rolled in readiness for use; when about to be used, they should be unrolled and tested, and then re-rolled. They are adjusted by unrolling them over the erect penis—they should never be drawn on as one draws on the finger of a glove. It is advisable, especially during the early days of marriage, or if the vagina is abnormally dry, that after the sheath is adjusted its outer surface should be lubricated with a special jelly. The best lubricants for this purpose are those which also destroy any sperms with which they may come into contact. Vaseline should not be used for lubricating a washable sheath, as vaseline and all other fatty substances have an injurious effect on rubber. A washable sheath should be examined for defects immediately after use; if it is found to be torn the wife should douche as soon as possible with about a quart of warm water containing four tablespoonfuls of vinegar, or with the same quantity of warm soapy water (a heaped tablespoonful of 'Lux' to the quart makes a suitable solution), or with plain warm water if neither of the above is available. While the douche is being prepared the presence in the vagina of a chemical contraceptive, such as one of the cocoa-butter or gelatine pessaries, or a foam tablet, or a contraceptive jelly, will greatly increase the chance of success in the prevention of conception. If such a chemical is not used in conjunction with the sheath as a routine, it should be available to be inserted immediately a defect in a sheath is discovered after coitus. If the sheath is to be preserved for future use, it should be washed, thoroughly dried, and powdered with French chalk (which can be bought from a chemist); or it can be kept in water. It is best kept flat, and not rolled until immediately before use.

A consideration of some of the causes of the failure of sheaths will emphasize the need for special precautions. Some of the causes are:

(1) The use of a defective sheath. A perished sheath may tear during use, although the defect was not apparent on testing before use. It is important, therefore, that sheaths should be bought from

a reliable source, and preferable that they should be dated by the manufacturers.

(2) Delay in adjusting the sheath until just before emission of semen. Sperms may be present in the moisture which is present on the penis from the commencement of coitus, and may succeed in entering the womb and fertilizing an ovum.

(3) A second coitus without the protection of a sheath, even if withdrawal is intended. Sperms from the first emission of semen may be present on the penis, and thus may be introduced into the vagina.

(4) Delay in withdrawing the penis from the vagina until after the erection has subsided. When the penis shrinks to its normal size the semen may ooze from the base of the sheath on to the lower part of the vagina.

There are some men to whom the sheath is useless; they lose their erection when they attempt to adjust it. Some women object to the use of a sheath on account of the smell of the rubber, or because it causes soreness of the vagina. The latter trouble is due to abnormal dryness of the vagina, aggravated by the absence of the lubricating moisture from the penis; it can usually be overcome by the use of a lubricating jelly. Finally, where for any reason it is desirable that the means of prevention of pregnancy should be in the hands of the wife, the use of a sheath is contra-indicated.

The sheath is particularly suitable in cases of premature ejaculation, in which emission of semen occurs almost at once after penetration. This is known popularly as 'being too quick.' The use of a sheath in such cases diminishes sensation, and may thus assist very much in the effort to delay ejaculation in order to permit normal coitus to take place. For use at the consummation of marriage and for the first three or four weeks of marriage, when the vagina is not sufficiently stretched for the satisfactory use of a mechanical appliance, the sheath is the method of choice.

MECHANICAL APPLIANCES.

Rubber Occlusive Pessaries. Rubber pessaries used to shut off the neck of the womb from contact with the semen are of various types and of several sizes. The correct use of any of these demands that in the first case it should be selected, both for type and size, by a doctor who examines the patient. An appliance which is quite harmless and suitable for one patient may be quite unreliable and harmful for another whose internal sex organs are of different size or shape and condition. Moreover, the most suitable type of appliance may be quite useless if not correctly used; the patient should therefore be taught how to adjust and remove it.

It must be emphasized that, since rubber occlusive pessaries—unlike the sheath—allow the semen to be deposited within the vagina and in contact with its surface, a rubber pessary used alone does not give adequate protection. When the pessary is removed living sperms may be present, and may then find their way along the vagina into the womb. A chemical contraceptive should therefore be used (suppository, jelly, tablet, or medicated douche) in conjunction with the rubber appliance. As fatty substances, such as cocoa-butter, vaseline, etc., have an injurious action on rubber, chemicals containing these substances should not be used with rubber pessaries.

There are three main types of rubber pessary now advocated by doctors.

(1) *The Dutch or Diaphragm Pessary.* This is the largest of the occlusive pessaries, and fits diagonally across the vagina, shutting off the upper part of the vagina—including the neck of the womb—and most of the front wall. As it is made in about twenty different sizes, the reader will appreciate that the fit of this pessary is of great importance. The sizes vary only by two and a half millimetres in diameter. The pessary has a flexible rim of watch-spring or coiled wire, which encloses the thin rubber diaphragm or shallow sac. Just before insertion the pessary is smeared all over with a contraceptive jelly or ointment. It may be put into the vagina any time during the evening, before intercourse; and as when properly adjusted and of the correct size its presence in the vagina is not perceptible to the wearer, it does not interfere with the spontaneity of intercourse. It should never be left in position for longer than twelve hours. Usually, therefore, it is adjusted some time before retiring to bed, in the evening, and removed the following morning, before or after breakfast, as is most convenient.

Now comes the choice of a chemical contraceptive to be used in conjunction with the Dutch pessary. There are gelatine suppositories, small tablets, which, on melting, form a foam, jellies, and foaming jellies; either of these must be inserted into the vagina before intercourse, according to directions, and after the rubber pessary is in place. The drawback to the use of these preparations is the need of inserting them just before intercourse; and some women object to this interference with the spontaneity of intercourse, and dislike the manipulations involved. They would therefore probably prefer the chemical douche, used the following morning when the pessary is to be removed. About a quart of douching solution is used, and the rubber pessary is removed midway in the douching process; that is to say, the vagina is first washed out, the neck of the womb is uncovered by removing the pessary, and then a final irrigation of the vagina completes the process. The pessary should be washed in warm soapy water, rinsed, and then thoroughly dried and powdered with French chalk. It should be

stored when not in use in a box or tin with a close-fitting lid, and kept in a cool dark place.

The actual instruction in adjusting and removing the pessary should be given by a doctor or nurse or midwife who is trained to give this instruction. The actual choice of the size of pessary should always in the first place be made by a doctor, since there may be conditions present, conditions recognizable only to a medically educated person, which make the use of this type of pessary—or of any other type—inadvisable. When the correct size is selected, however, any trained person can give instruction in the use of the pessary.

The patient to be instructed will first be taught to examine herself by inserting her finger into her vagina, and exploring the size and shape of this cavity. The main object of this is that she may feel and identify the projection at the upper end (the cervix)—a fleshy lump in consistence rather like the tip of the nose—which is the neck of the womb. She should be made to understand that unless this projection is covered by the rubber pessary, she is in no way protected against conception. It is possible to place pessaries in the vagina without covering the neck of the womb; and this is undoubtedly the cause of some of the failures in the use of the appliance. Fortunately, the thinness and looseness of the rubber diaphragm enables the neck of the womb to be felt quite clearly by the finger when the pessary is properly adjusted; the patient can thus check the correct position of the pessary by feeling for the cervix through the rubber diaphragm which covers it. The position which is most commonly found best for these manipulations is the squatting position, but each woman will find by experience which position is most comfortable to her.

The pessary, lubricated with the jelly or ointment, is held with the rim compressed between thumb and fingers of the right hand (or left hand if the patient is left-handed), so that the circular rim becomes flattened and elongated. It would not be possible to insert the pessary through the opening of the vagina in its original circular shape; but as the rim is flexible it can be flattened sufficiently for the purpose. The pessary is then pushed into the vagina so that the part which first enters passes along the back wall of the passage and behind the neck of the womb, and the final part of the rim to enter is tucked just under the pubic bone in front. The pessary is placed with the dome uppermost, so that when the projecting womb pushes the rubber diaphragm downwards, a shallow gutter is formed between the rim and the cap. This gutter is most useful when removing the cap, as the tip of a finger can easily be pushed into it to get sufficient purchase on the rim to pull out the pessary. If the pessary is put in the other way up—concavity uppermost—the patient will appreciate how much more difficult it is to remove it, as the finger must then be forced round and over the rim

in order to get a grip of it. After removal the rim of the pessary should be gently remoulded between thumb and fingers to restore its original circular shape.

Suitable lubricants for the pessary are:
'G.P.' Ointment or Jelly (Gilmont Products Ltd.).
'Contraceptaline' (Lamberts Prorace Ltd.).
'Milsan' jelly (Menosine Ltd.).
Soapy water (preferable if a foam tablet is to be used).

Spermicidal lubricants usually contain chinosol or quinine; their reliability is usually doubtful.

(2) *The Dumas Pessary.* This pessary is shaped like a shallow bowl, and is made entirely of rubber, the thickened edge giving it sufficient rigidity. It fits close up to the upper end of the vagina, and thus covers the neck of the womb. Unlike the third type of pessary to be described the Dumas pessary does not fit on to the neck of the womb. This pessary is made in three sizes only, and is usually advised in those cases in which there is not proper support for the rim of the Dutch pessary, as when the vagina has been badly stretched after the birth of several children, or when there is not sufficient space behind the pubic bone in front to support the rim of the Dutch pessary. The Dumas pessary is compressed between the thumb and fingers, and inserted into the vagina with the dome downwards. As soon as it has entered the vagina, it is allowed to open out and is pushed to the extreme end of the passage, so that the neck of the womb lies in its concavity and the edge of the pessary is in contact with the top of the passage. It is not so easy to remove as the Dutch pessary, because the finger must reach to the upper end of the vagina in order to hook over the edge of the pessary and pull it out. When the pessary is in position the neck of the womb cannot be felt through the thick rubber; the finger must be pushed over the edge of the tilted cap to make sure that the neck of the womb is covered by feeling this projection within the pessary. After checking its position in this way the tilted pessary should be firmly pressed back into position. This type of pessary should not be used if the neck of the womb has been badly torn during child-birth, or if there is a copious vaginal discharge; and in any case, it should never be left in position for longer than twelve hours. As in the case of the Dutch pessary it should be lubricated with a contraceptive ointment or jelly or with soapy water, and a chemical spermicide or a douche should be used also.

(3) *The Cervical Cap* ('Prorace,' 'Racial,' and other models) is the smallest of the rubber pessaries. It is made in four sizes, and in shape resembles a thimble. It is designed to fit on to the neck of the womb (cervix). It is adjusted in the same way that the Dumas is adjusted, and like all other rubber pessaries, it requires a lubricant and should

be used only in conjunction with a chemical contraceptive. It should never be used if the neck of the womb is torn or unhealthy, or in the presence of a discharge. It is particularly important that this type of pessary should be used only on the advice of a doctor and that the correct size should be selected by a doctor. If the pessary is too small or the dome too shallow, serious injury may result. Some doctors disapprove of this type of pessary in any case because they fear the possibility of setting up a chronic inflammation of the womb, and for other reasons which do not apply to the two other forms of rubber pessary described above. It is most important, then, that the cervical-cap type of pessary should never be used without the sanction of a doctor, and that the usual precaution of not leaving it in position for longer than twelve hours should be observed. If after removal the cap is found to be filled with discharge the writer believes that its use should be discontinued, and some other type of pessary or some other method of contraception substituted. This pessary is inserted in the same manner as is the Dumas, and is pushed on to the neck of the womb, which can be easily felt through the thin rubber dome.

After use all rubber pessaries should be washed, dried, and powdered with French chalk, and kept in a box or tin, with a close-fitting lid.

The final test of the suitability of any rubber appliance comes when it is actually in use during sexual intercourse. If the patient or her husband is conscious of any discomfort due to the presence of the appliance, or of any lessening of sexual satisfaction; if the appliance is dislodged during intercourse; or if on removal it is found to contain much discharge or any trace of blood, the doctor should be informed so that he may consider the advisability of prescribing some other method of contraception. Moreover, some medical treatment may be indicated, as a vaginal discharge (other than a slight amount of whitish discharge just before and after menstruation) or any bleeding at all (except during menstruation) is not normal; either indicates a need for medical investigation and treatment.

In the course of time any appliance, which was quite suitable and harmless when prescribed, may become unsuitable owing to changes in the condition of the womb and vagina. It is advisable, therefore, to keep in touch with the doctor, and to have a routine examination at intervals of six months or a year, in case it becomes advisable to change the size or the type of appliance.

Sponges. The woman who is unable to consult a doctor for the choice and fitting of a rubber occlusive pessary, or who cannot use such a pessary because she wears a ring to support a prolapsed womb, or who on examination proves to be unsuitable for such an appliance, may be advised to use a sponge as a mechanical contraceptive. The small round natural sponges which are still being sold for birth-control are

in most cases quite useless; during intercourse they are easily pushed aside, leaving the neck of the womb exposed. The best type of sponge, such as the 'Racial,' is a flattened disk-shaped soft rubber sponge, sufficiently large to cover the whole of the roof of the vagina, and about an inch thick. Such a contraceptive sponge can be cut from an ordinary rubber sponge, and there is no need for an enclosing net and string attachment if the patient can remove the sponge from her vagina by hooking her finger over its edge and getting sufficient purchase to pull it out. When it is about to be inserted, the sponge should be soaked in some contraceptive fluid (such as olive oil, soapy water, or equal quantities of vinegar and water). The second line of defence should be a chemical contraceptive (suppository, tablet, or jelly), or a douche used the following morning when the sponge is removed. After use, the sponge should be washed in warm soapy water, thoroughly rinsed, and either kept in a solution containing disinfectant or else dried. Occasionally it should be boiled for a minute.

Vaginal Plugs. A pad of cotton wool or gauze or fine butter muslin, sufficiently large to spread over the whole extent of the upper part of the vagina, can be used as an emergency measure, and is particularly useful for women in outlandish parts of the world who are not in touch with a doctor. The pad should be soaked in lemon juice or in vinegar and water (equal parts), and smeared with vaseline or contraceptive jelly. The pad should be removed the following morning after intercourse, and discarded; a new pad should be used for each occasion. If there is any difficulty in removing the pad a thread attachment can be tied to it, long enough to protrude from the vagina when the pad is in position. By pulling on this thread the pad can then be easily removed. If cotton-wool is used it is a good plan to enclose the pad with a covering of thin, open-meshed gauze. After the pad is adjusted additional security is achieved by inserting a chemical contraceptive. Since rubber is not used, the cocoa-butter suppositories are quite suitable in this case. A douche of vinegar and water or lemon juice and water (two tablespoonfuls to the quart in each case) or of plain warm water, will give still further security.

THE DOUCHE.

The douche, which combines a chemical and a mechanical contraceptive action, should be used only in conjunction with some appliance which covers the neck of the womb. If the semen is ejaculated on the neck of the womb sperms may succeed in entering the womb almost immediately, in which case they are quite unaffected by subsequent douching, even though the douching be carried out immediately after intercourse. There are reasons, too, why it is most unwise to rise and prepare and administer a douche immediately after intercourse, for this

is the time when there should be absolute rest and repose, culminating in normal sleep.

It should be clearly understood that a daily douche (except when a medicated douche is ordered by a doctor as treatment for a diseased condition) is most unwise and may be dangerous. The healthy vagina does not need a daily irrigation; and too frequent washing away of the natural protective secretions may pave the way for an acute inflammation. For contraceptive purposes, where besides killing and removing any living sperms that still remain it is desirable to wash away the residue of any chemical preparations that have been used, douching twice a week is harmless and advantageous.

Contraceptive douching is advised:

(*a*) In conjunction with a rubber pessary, sponge, or vaginal plug, when it should be deferred until the morning after intercourse; and

(*b*) as an emergency measure when a sheath has torn during intercourse. The douche should then be used as soon as possible after intercourse; and a soluble suppository or tablet, or a jelly, should be inserted into the vagina at once so that it may afford some protection while the douche is being prepared.

Method of Douching. The irrigation of the vagina can be carried out by means of a whirling spray, an enema syringe (using the vaginal nozzle supplied), or a douche can or bag with tube and nozzle. For the early days of marriage, when the opening of the vagina may still be very small, the enema syringe or douche can is most suitable, as the nozzle of the whirling spray is sometimes too thick in such cases.

To be really effective the douching solution should not merely trickle in and out of the vagina. The lining of this passage is not quite smooth; it is thrown up into folds with intervening depressions; it is also very elastic. It is advisable that the passage should be slightly distended by the solution so that it may come into contact with all parts of the surface. Unless the woman douches while she is lying down (as when using the douche can and tubing), in which case sufficient distension is probably achieved owing to her position, she should make use of the collar or flange supplied with the whirling spray or enema syringe, or should compress the lips of the vulva with her fingers around the base of the nozzle, and allow the douching fluid to escape in gushes and not to trickle away continuously. The flange supplied should be adjusted at the base of the syringe nozzle and pressed close to the vulva to control the outflow in the manner desired. The distension of the vagina should be such that there is no discomfort from the pressure. With this precaution there is no possible danger of forcing the solution into the womb. Douching can then be carried out in a sitting or crouching position. After use the nozzle should be thoroughly cleansed in plain warm water.

Douching Solutions. The douche should always be warm, at about body heat. It is dangerous to use a cold solution.

Plain warm water is known to immobilize and probably to kill sperms quite quickly, and therefore a plain douche of warm water is probably quite efficacious. Most women prefer, however, to use a medicated douche because of the greater feeling of security it gives. The following substances, *dissolved in a quart of warm water*, are suitable:

Soap. Two level tablespoonfuls of 'Lux' or a piece of pure super-fatted toilet soap of a size equivalent to two large cubes of sugar. The soap must be thoroughly mixed to form an emulsion. Cheap soap flakes or strong household soaps should not be used on account of the excess of soda, which may prove irritating.

Lemon Juice. Two tablespoonfuls.

Vinegar. Two tablespoonfuls.

Lactic acid. One teaspoonful. This is a clear fluid which may be obtained from any chemist.

CHEMICAL CONTRACEPTIVES.

There are many chemical contraceptives on the market, some of which are advertised with unjustifiable claims of complete reliability even when used alone, without the additional protection of a rubber appliance. The writer has known every type of chemical contraceptive, when used alone, to fail. It should be realized that manufacturers who are anxious to promote the sale of their particular product are apt to be unduly optimistic or even unscrupulous in claiming success. Some products are much better than others, and it is well to take the advice of a doctor in the choice of the most suitable chemical contraceptive in any particular case. The doctor takes into consideration such things as cost, the frequency of use, and any special factor such as residence in a tropical climate.

The essential constituent of a chemical contraceptive is a substance which will rapidly kill or render motionless the sperm-cells in the semen, so as to prevent them from making their way into the womb. This is combined with other substances to give suitable bulk and consistency. The proper function of a chemical contraceptive is use in conjunction with a rubber vaginal pessary or a sheath. If the sheath were untearable there would be no need for the chemical; the presence of the chemical is some protection against pregnancy should the sheath be defective and so allow sperms to enter the vagina. When a rubber vaginal pessary, such as the Dutch cap, is used, the whole of the semen, containing millions of living sperms, is deposited within the vagina; the object of the chemical contraceptive is to kill or immobilize these sperms before the rubber cap is removed. In women of low fertility, or if intercourse is restricted to the relatively safe period, a chemical

contraceptive alone may prove efficacious. It should be clearly understood, however, that if the greatest possible protection against pregnancy be desired it is essential to use a mechanical barrier in addition to the chemical.

Types of Chemical Contraceptives.

(*a*) *Soluble Suppositories* (*pessaries*), in which the chemical contraceptive is incorporated in a base of cocoa-butter or gelatine, melt at body temperature. Since cocoa-butter injures rubber, gelatine should be selected for habitual use in conjunction with a rubber appliance. Odourless or scented cocoa-butter suppositories are now available.

(*b*) *Soluble Tablets* (*'foam tablets'*), which dissolve in the vaginal fluids to form a foam. It facilitates solution if these tablets are moistened in water—preferably warm water—immediately before insertion. Most of the manufacturers advise that the tablet be inserted about six minutes before intercourse. In fact, the time required for solution depends largely upon the amount and character of the vaginal fluids, and in many cases a considerably longer time is required. In some cases the tablets fail to dissolve at all. These tablets should never be used during the honeymoon, as contact with abrasions caused during the consummation of the marriage may cause intense smarting.

(*c*) *Jellies* (*foaming and non-foaming*) have the advantage that they are effective from the moment of insertion; no time is required for solution, and they are not dependent upon the vaginal fluids.

(*d*) *The Douche* containing vinegar or lemon juice is a chemical contraceptive, since the solution kills or immobilizes the sperms besides washing out the vagina.

Method of Use. When the chemical suppository, tablet, or jelly is used in conjunction with a rubber pessary, it may in each case be inserted after the rubber appliance is in position. The rubber cap may be adjusted an hour or two before retiring, so that there is the least possible interference with the spontaneity of intercourse. Some doctors, however, advise that the chemical be placed above the rubber cap. Where the former method is employed, the patient should remain in the lying-down position so as to prevent the dissolved chemical substance from flowing out of the vagina before intercourse. The suppository or tablet will not be effective unless it dissolves completely before intercourse takes place. Some patients are unusually affected by certain chemicals; and a suppository, tablet, or jelly which is used with perfect comfort by one woman may cause irritation or smarting of the vagina in another case, and may therefore have to be discarded. There are a large number of effective preparations from which to choose, and prices vary from two shillings to ten shillings a dozen. The doctor's advice should be sought regarding the most suitable preparation in any particular case.

General Advice

Birth-control is a medical matter, therefore a doctor's advice and instruction should be sought. It may become necessary to change the method in use, according to special circumstances. For instance, during travel or holidays, the douche may be inconvenient and, therefore, a soluble suppository or tablet or a jelly should be substituted. After childbirth, or within six months of marriage, or at other times, a change in the type or size of rubber pessary may be advisable.

By the wise and moderate use of birth-control, parenthood can be properly planned with due consideration for the health of the mother and the welfare of the family, and at the same time the normal sexual needs of husband and wife can be met. As in the case of all the benefits of humanity resulting from scientific knowledge, birth-control can be abused, just as food is abused when people overeat, or as games and sport are abused by immoderation. To say that it is 'unnatural' is saying nothing; it is unnatural to seek medical aid for sickness, to wear clothes or eyeglasses or false teeth; indeed, most of the benefits of civilization are unnatural. What does concern us is that the method of birth-control selected shall be medically approved as reliable, harmless, and suitable for the particular case.

V—MIDDLE AGE

One is apt to think of the seven ages of man as if their divisions were water-tight compartments. A much more correct view of the matter is expressed in the saying that the child is father of the man. But even this does not sufficiently emphasize the influence that each stage exercises upon the succeeding stages, and the indelible mark which environment leaves on each. A person at any given stage may truly be said to be the resultant of the conditions of his past life. This is to be borne in mind at every stage, but its truth becomes increasingly impressive as the years pass by, from the age of forty-five onwards. It is at this period, the meridian of life, that the seeds sown in childhood, youth and maturity are coming to florescence and fruition, and a wise man is therefore moved to pause and take stock of his physiological position. As a piece of animal mechanism he has waxed and waxed; soon he will begin to wane; it is for him to make the intervening period as long as possible and as fruitful as possible; how is he to do it? The answer to this question is comprised in the word moderation. He must not on the one hand resign himself prematurely to the results of time, nor must he on the other seek to decorate the period of full maturity with the trappings proper to youth. He must neither loll in a Bath chair, nor captain a football team. 'Discern of the coming on of years,' says Bacon, 'and think not to do the same things still, for age will not be defied.' This refers more particularly to the purely physical side of life; in the sphere of the intellect there ought to be no sensible decline until a much later period; it is indeed the case that many men have shown themselves mentally at their best when well passed the Psalmist's threescore years and ten. In the matter of the intellect, Martin Luther's rule should be the guide: 'If I rest, I rust.'

Exercise

In taking stock of the physical position he will, if he is honest with himself, find a good deal that wants altering, much that requires checking, and still more that demands uprooting. It is for example a well observed fact that men who have been athletes in the days of their muscular prime, have acquired at that time the, perhaps justifiable, habit of large meals, and that the habit has continued long after the athletic justification has ceased to operate. Most athletes are obliged sooner or later to relinquish their outdoor activities in order to engage

in the serious business of life. Their lessened muscular output should lead to a very much diminished alimentary intake both in quality and quantity. But this very seldom happens at first. When it is brought home to a man with any physical self-respect that his lessened muscular expenditure, together with his sustained alimentary intake, are leading to abdominal obesity and to breathlessness on moderate exertion, he realizes that an effort to redress the balance is now called for, and he makes his dispositions accordingly. Many a man, when rallied on the question of his figure, will protest that there cannot be much the matter because his weight at his athletic best was the same as it is to-day, in his athletic gloaming. Upon which the obvious, if brutal, retort must be that in the old days the weight connoted hard muscle carried in the appropriate places on his limbs, whereas the weight to-day means soft, almost semi-fluid fat, which protrudes in unsuitable convexities about his trunk.

In discussing the question of weight, especially of increasing weight, nine Englishmen out of ten will express themselves in terms of exercise. And yet, as a scientific fact, exercise has much less to say in the matter than is generally supposed. This, to the astonishment of most people, has been shown by a Chicago physiologist. He set himself to determine the amount of exercise necessary to remove one pound of fat from a fairly healthy body, and concluded as follows: 'In order to wear off a single pound of fat by exercise, the average sized individual must either fence eight hours, wrestle five and a half hours, walk one hundred and forty-four miles at the rate of two miles an hour, or play football hard for four and four-fifth hours.' . . . It is not difficult to see in such experiments a sufficiently large margin of error to invalidate any dogmatic inference, but there is enough of point in them to show that the prime importance hitherto attributed to exercise in the reduction of weight must undergo serious revision. Yet some observers hold that exercise has a great influence in the reduction of size. Du Bois, for example, says that a decrease in activity comparable to the walking of a mile and a half a day might result in the deposition of a third of an ounce a day or about eight pounds in a year. After all, overweight is not a disease, it is merely an indication that the physiological balance is upset, and as it is a sign which he who runs may read, it is often regarded as the most important, merely because most obvious, of many pointing in the same direction. There are certain tables published on penny-in-the-slot machines and elsewhere which give approximately correct weights for height and age. That there should be a sliding scale for height is quite obvious, but there does not seem to be any excuse for the wide differences which these tables permit between the weights of the same individual at different periods of his life. To allow, for example, as most of them do, an increase of a stone (14 lb.)

between the ages of twenty-five and fifty, though doubtless deplorably common in fact, has no excuse in principle. The middle-aged man should not allow himself to be guided by such tables. He is indeed wise if he seeks so to order his way of living as to secure a weight rather under the minimum allowed by the tables. It is a true saying which tells that spareness is a token of long lasting and warns us that fat men don't make old bones. The factor of greatest importance in regulating weight and contour is of course diet. It is the quantity and quality of the food taken which matter most; a question to which we shall return later.

The value of exercise at middle age is not only or indeed chiefly a question of corpulence, it is a question of getting rid of the waste products of tissue change. These waste products, which are toxic, must be so treated that they become harmless, and they are for this reason and to this end burned up in the muscles. This expression is no figure of speech. The material is oxidized in the muscles by the heat generated by their contraction, in exactly the same way that coal is burned in a grate, and unless the fires are kept burning briskly, the waste toxic products are not properly consumed—they are burned to cinder and not to ash—with the result that they tend to accumulate in special situations, and middle-age troubles such as rheumatism, neuralgia, and fibrositis become common. If the intake of food is not diminished and the output in muscular contraction is inadequate, the toxins remain lurking in the tissues and a slow chronic poisoning results.

Cleansing the System

It is important to bear in mind this conception of ordinary more or less healthy living as a state of slow poisoning. It has been said that as soon as a man is born he begins to die. This is in a sense true. He begins to die because he begins to poison himself. At first the poisons which he manufactures in his ordinary physiological processes—feeding, movement, respiration, and the like—are very readily neutralized by the antidotes which Nature provides, but as time goes on the poisons increase both in number and potency, and the antidote factory tends to become exhausted from overwork. If man begins to die at birth, the pace at first is slow; it becomes accelerated as time goes on, until at length the poisons gain the upper hand, and the end comes. The pace at which the slow poisoning proceeds and the form which it takes depend upon many things. The poisons vary with the individual; those which gradually overtake and smother Jack differ from those which stifle Tom and those which afflict Jill. The toxins which thus accumulate, and begin about middle age to make their presence severely

felt, are not only alimentary ones, taken in from outside in ignorance or wantonness; others are manufactured in the system itself.

Every physiological act, however simple, breathing, walking, writing, thinking, necessarily uses up material—burns petrol—and, in the using, creates waste products. There are means for the disposal of these waste products, and in healthy people the work is well done, but if the waste products are in continual excess, the machinery has to be driven at high pressure, and in consequence shows wear and tear sooner than it should. It is wise to look for evidences of such wear and tear in the forty-to-fifty decade we are now considering, in order that any fault may be found and corrected. A good many of these dangerous waste products are, as already explained, rendered harmless by being burned up in the muscles; others undergo a chemical change which transforms a complicated into a simple structure, easy of disposal. The more important of the waste products are, however, passed on to the main excretory organs for expulsion from the body. These organs are the kidneys, the lungs, the skin, and the bowels. Now, about these great organs it is important to remember a very simple fact which is far too often overlooked, namely, that they are banded together in a sort of brotherhood by virtue of which, if one organ is disabled, one or two or all of the others will come to the rescue and try to aid in the excretory work of the disabled or indisposed member. But inasmuch as each is armed and engined to do certain very highly specialized work, its ability to undertake the task of another member while still attending to its own is limited, and is very liable to embarrass the proper performance of its own job.

Keeping the Blood Pure

It is to be remembered that everything that reaches the tissues, whether it be boon or bane, is carried there by the blood. The blood may be very unwilling to carry certain substances, and may do its best to rid itself of harmful material as quickly as possible. But when the harmful material is supplied in small doses at first and later in gradually increasing quantities a tolerance is established, till after a few years the blood will accept an amount of a particular poison which if tendered in the first instance it would have made a vigorous attempt to expel. The repair material destined for the tissues is taken from the digestive tract and added to the circulating blood which delivers it to the appropriate organs. When any particular organ has utilized its share of this material there result certain waste products which it is the duty of the blood to remove and to carry to the agencies which will render them harmless. It is thus not only a purveyor of necessaries, but also a scavenger of refuse, and it is upon the proper performance of this latter

function that the well-being of the individual largely depends. To go without sufficient food is bad, but in the presence of plenty to be clogged up with refuse is infinitely worse.

The necessity for maintaining the blood in a high degree of cleanliness cannot be over-emphasized. The very complexity of composition and extraordinary variety in function of the vital fluid seems in a curious way to mask the fact that all the processes of tissue change, whether in stomach, muscle, bone, or brain, are carried out in a fluid medium. It is difficult to realize that the tough, solid, hefty food which we place in our mouths must be transformed into a fluid nearly resembling milk in appearance and consistency before it can be utilized by the appropriate organs for the repair of waste. And if we try to visualize the amount of energy demanded by the conversion of so much crude solid into the equivalent of bland fluid it becomes easy to understand how such complicated machinery may go wrong. Watching the ways of the majority of people in the matter of food one is surprised, not that the digestive processes occasionally go on strike, but that they do not fail completely more often than they do.

An important implication of these considerations is that people should make a point of taking a sufficiency of fluid to enable the blood to do its work easily. Fluid is normally lost in considerable quantities through all the excretory organs, notably the kidneys, which void from three to four pints daily, lungs which give off a pint, and skin which loses at least a pint by insensible perspiration. This loss should be balanced by a full intake of simple fluid, either water as such, or the fluid present in uncooked fruits and vegetables. Water containing a small quantity of tea or coffee is fairly free from objection, but a fluid such as milk, which is merely a concentrated food in liquid form, has little or no value for the work of flushing and dissolving, which is the process now under consideration. Alcoholic drinks, which are what is called 'food sparers,' even when they are not, as beer is, a true food—though much better than milk for this purpose, are not entirely free from objection. The flushing and solvent duties of the fluid ingested should always be born in mind. The blood and tissues are jealous custodians of their fluid, they will not part with more than a certain proportion of it, so that, unless the supply from outside is liberal, the undischarged fluid is forced to store concentrated toxic material which it would fain carry away. The undoubted efficacy of many 'cures' at health resorts is due mainly to the large quantity of fluid taken in the course of the treatment, and is not, as is often supposed, the result of some special ingredient in the natural mineral water. The spas which are able to show the best results in the rheumatisms and fibrositis and neuralgias of middle age are those which combine baths and physical methods such as massage with the drinking of plenty of

fluid. Of such the best known are Vichy, Aix-les-Bains, Evian, Vittel, and Contrexéville. Some enthusiasts, recognizing the desirability of drinking a fluid with a high solvent power, have taken distilled water by the mouth. This is a mistake. Distilled water is too 'searching'; a fact of which, as has been pointed out, any one may convince himself by putting a drop or two into the eye. The pain, though momentary, is very intense; a reaction which does not ensue when ordinary tap-water is used.

It should thus be obvious that of the means of defence with which we are furnished against the chronic poisoning that is liable to overtake us at the meridian of life, a really active blood-stream, constantly depurated, and reinforced by water, ranks as among the most important. The scavenging work of the blood is not usually given its proper weight; people think only of what is borne in on the stream in the way of repairing material; they rarely consider the dangerous waste products which by this means are busily and carefully removed from the tissues and handed on to the excretory organs for final disposal. An authority has recently told us that 'water is the body's greatest need. To get the maximum nutrition out of solid food water should be taken in small quantities at frequent intervals during a meal. It has been proved by experiment in man and animals that a reasonable dilution of solid food in the stomach makes the food go further. A dietary which, taken without water, will not suffice to maintain the balance of intake and output can be made to do so by adding water to the meals. In the past there has been much discussion as to the proper time for ingesting the all-essential fluid. To take it during a meal, as recommended above, is said to run counter to the lessons to be learned from the lower animals, none of which drink with their meals. It is, moreover, asserted that water taken with a meal dilutes the gastric juices and interferes with digestion. It is nevertheless proper to point out that experience at health resorts and elsewhere has shown that a good time for the drinking of fluids, if these be taken in large quantities, is an hour before the principal meals. Fluid should always be taken deliberately in small mouthfuls at a time, and whenever possible should be immediately followed by a period of complete rest.

The Excretory System

Let us now look at these excretory organs—emunctories, they are called—in a little more detail, always bearing in mind that though there is nothing about these organs which is especially to be feared at the meridian of life, it is at this period that the first signs of wear and tear are liable to show themselves.

The food which is taken into the body and utilized, replaces material

which is worn out, and is consequently not only useless but poisonous. This material, the end-result of tissue change, is voided as urine by the kidneys, via its reservoir, the bladder. The duties with which the kidneys are charged are extremely important. If these organs altogether fail to perform their excretory task, lethal poisons collect in the system, and death is the rapid and inevitable outcome; and even when the failure is but partial, the results are highly dangerous to life. Roughly speaking, the kidneys may be regarded as filters which, while allowing effete matters and other poisons to pass through, ensure the retention of valuable material. Normally, their selective capacity is very keen. They are quick to void undesirable matters and comparatively leisurely in discharging those which, though useless, are harmless. They are very sensitive to various influences, and are called in aid when any of the other excretory organs fail adequately to perform their respective tasks. Thus, they are much more active in cold weather when the loss of water by the skin is reduced. Their activities are very much increased when the bowels are constipated, and when the intestinal glands are lazy in the performance of their antiseptic functions; when, that is, poisons tend to accumulate in the system. Like the bowels, they respond at once to poisons introduced from without, which they do their best to get rid of as soon as possible. Nervous influences of various kinds will produce a very large, in some cases an enormous, outflow of urine. Some diseases, such as diabetes and certain affections of the kidneys themselves, are accompanied by an increased output. In view of these facts it should be recognized that a condition exists which may properly be described as renal diarrhoea, of which people would do well to take cognizance; not, however, as an offence to be corrected, but as a warning to be heeded. Some articles of ordinary food or drink are liable to produce end-results which irritate these delicate organs, and in the absence of any obvious cause for a renal diarrhoea, such substances should be sought for and rigidly excluded from the schedule. As people have curious idiosyncrasies in this respect, it is quite impossible to lay down any rule, but it may be said that such apparently harmless substances as tea, coffee, and some wines, especially champagne, act in this way on many seemingly healthy people.

That large and important organ, the skin, is charged with many duties, but its work as an excretory organ is seldom appreciated as it ought to be. Practical experience teaches us that this large surface, more or less exposed to the air, is capable of doing a vast amount of excretory work which cannot well be performed elsewhere. As in the case of the kidneys, the skin does its work by the medium of water. Apart altogether from the sensible perspiration, to be considered immediately, we have to remember that watery vapour in an insensible form is exhaled from the surface of the skin just as it is

exhaled from the lungs. It is, in fact, evaporated, and the main purpose of this evaporation would seem to be the regulation of the heat of the body. Nor is it only watery vapour which is thus given off. We have little difficulty in convincing ourselves that in actual practice gaseous emanations, sometimes of a very pungent kind, habitually accompany the watery vapour, and there can be no reasonable doubt that these emanations are of such a nature as to render their discharge in the highest degree both physiologically necessary and aesthetically desirable.

Sweating then must be regarded as one of the normal physiological methods of excreting waste products from the system, and should be cultivated as a very easily attainable means towards the maintenance of health in middle age. Inasmuch as the water discharged by this route is liable to be large in quantity, care should be taken to replace it by drinking a sufficient quantity of fluid, otherwise the bowels and kidneys may find themselves deprived of the vehicle essential for their activities. That the skin may be induced to undertake a considerable portion of the excretory work of the kidneys is well known to doctors, who are in the habit of prescribing sweating processes to patients suffering from inefficiency of the kidneys, as in certain forms of Bright's disease. That it may, and frequently does, perform some of the work of the inactive bowel is all too frequently and unpleasantly forced upon the consciousness even of the most unobservant, by the foetid faecal odour which emanates from the skins of usually meat-eating people who lazily allow themselves to be continually constipated.

The air which we inhale is dry. Its dryness depends upon climatic humidity, which varies between, say sixty-five in a dry climate, such as that of Egypt, and eighty-two in a humid climate, such as that of the south-west coast of England. The air which we exhale is entirely saturated with moisture, representing in relation to the above figures the maximum of one hundred. It follows that the greatest amount of water which can be removed from the body by this route will escape during muscular exercise in an atmosphere which is cold and dry. That is the reason why keen, dry air is felt to be invigorating: it invites to muscular exercise. Thus, the lungs excrete water: they also excrete carbonic acid gas. This last is a poison which is manufactured in the tissues, and as voided is at once replaced by oxygen, which is essential to the tissues. The exchange of carbonic acid for oxygen which takes place in the lungs has already been referred to, and certainly constitutes by far the most important function of these two large organs. The bodily system is relatively tolerant of carbonic acid, poison though it really be. It is especially tolerant when the poison is imposed upon it by degrees as, for instance, in crowded assemblies, where it accumulates in the atmosphere bit by bit.

What has been said above concerns pure carbonic acid gas, uncontaminated with the organic vapours which are to be found in air exhaled from ordinary human lungs. The addition of such contamination naturally renders the air containing the carbonic acid even more poisonous, and although it may be true, as authoritatively contended, that apart from its carbonic acid content, the exhaled breath of a perfectly normal person is not toxic, experience would suggest that in this matter there must be very few perfectly normal persons. We are therefore forced to the conclusion that in addition to water and carbonic acid, the lungs are charged—exceptionally perhaps, but still charged—with the duty of excreting certain other substances of a deleterious nature; that they are, in fact, supplementary excretory organs. It is well known that in middle and later life there are such things as gouty bronchitis and gouty asthma, but it is not always realized that the occurrence of these is due in part to an effort on the part of the bronchial tubes to aid in the expulsion of the gouty poisons. There are indeed many whose opinions are justly entitled to respect who hold that bronchitis is always due to a weakening of the bronchial soil by the ceaseless endeavour of gouty and similar poisons to force an exit by this route. That this view is in the main correct seems highly probable, and if it is correct, it means that the way to avoid bronchitis is not by the stereotyped methods of feeding to 'keep up the strength,' and coddling to keep out the cold, but by such a restricted dietetic regime and general depuration of the system as will remove the illegitimate excretory strain from the bronchial tubes, and allow them to concentrate upon their legitimate work. The same is true of gouty asthma.

The lungs then must be regarded as supplementary excretory organs; but the system does not call upon them until it is in sore straits. When it is evident that they have been so called upon, and are operating in the front line, the proper course to adopt is to check the necessity for supplementary excretion by suitable general measures and by stimulating the activities of the ordinary excretory organs. The occasion is not one for poultices, linctuses, and bronchitis kettles; rather does it suggest old-fashioned aids to salvation, such as black draughts, sweating, fasting, and blood-letting. The nice old gentleman with a 'nasty cough,' and Aunt Matilda who is 'a martyr to the bronchitis,' deserve, not only pity, but also a purgative. It is, of course, true that irritants reach the bronchial tubes from without, especially in large cities, but the most frequent and irritating irritants come from within, and they do their irritating in trying to find an exit.

We take into our systems a considerable quantity of material which, though quite harmless, is nevertheless useless from the point of view of repairing waste. Such a substance is vegetable fibre, which is

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THE FOUR TYPES OF MAN

Melancholy: Sanguine: Choleric, and Phlegmatic
From a German Engraving of the sixteenth century

by its nature insusceptible of being dissolved by the digestive juices. When this fibre has been stripped of the useful material with which, in an ordinary vegetable, it is associated, the fibre itself is passed out along the intestines, and is ultimately discharged. A very large proportion of the matter evacuated as faeces consists of material of this kind. It used at one time to be thought that faeces were composed wholly of material which was not susceptible of digestion, and there is little doubt that, in a perfectly balanced scheme of intake and output, this would be nearly true. Unfortunately, however, our present scheme of living represents the reverse of a perfect balance; the dice are loaded in favour of the intake, so that Nature wisely utilizes the intestinal tract as a means of expelling a great many substances other than vegetable fibre and its equally harmless congeners. And many of these other substances are not only highly toxic, but are toxic in the very special and disastrous sense of paralysing the tract through which they pass. Some of the extraneous material which finds its way into the bowel does not so paralyse the tract: it irritates it, and diarrhoea with colic is the result. Such an event, unpleasant though it be, is a storm which soon wears itself out, and no ultimate harm ensues. With the paralysing toxins, however, the case is very different. They produce a partial paralysis of the bowel, thereby not only protecting themselves against discharge, but also ensuring a re-absorption into the circulation. Such is the secret of many cases of constipation, and the explanation of some of its terrible results.

There is another and a very important factor which enters into the production of overloading of the bowel, and that is the voluntary control exercised by the individual. The education of this control constitutes a very necessary part of the upbringing of the child; in obedience to social and scholastic demands, it is gradually strengthened in the growing period, so that when adult age is reached the control has acquired such an ascendancy over the original physiological desire for relief that the latter is scarcely appreciated, save at certain hours, and then but feebly. Civilized man, it has been said, spends one-half his life in cultivating constipation and the other half in campaigning against it.

These two elements, the excess of voluntary control and the paralysing effect of the toxins on the movements of the intestines, combine to produce the most serious effects upon the constitution. The retention or inadequate discharge of faecal matter leads to re-absorption of poisons of every description, with the inevitable result that the human soil becomes so richly manured that any and every microbe settles thereon and flourishes exceedingly. And, apart from frank and blatant microbic invasion, one has to remember the gross impurity of the circulating blood to which such a state of affairs gives rise. We have

seen that for the efficient performance of its functions every part of the body is dependent upon a pure blood supply. If the circulating fluid is loaded with toxins, as in chronic constipation it invariably is, then not only does the whole machine work badly, but certain parts of it, the most delicate, become perverted in their action. It is within the experience of most adults that inaction of the bowels, even though it be relative only, depresses the nervous system, giving rise to a lugubrious outlook on life which, on the necessary alvine relief being obtained, is changed at once to animation and optimism. It is surprising to find how commonly the hypochondriac, the kill-joy, and the croaker suffer from constipation.

It is sometimes said that the taking of purgatives and laxatives constitutes a bad habit, which, like other bad habits, should be resisted. If it be true—and the proposition is a debatable one—that purgatives are physiologically objectionable, it is true to a far finer degree of truth that even more physiologically objectionable are the evils which chronic intestinal stasis brings in its corrupt and unclean train. In comparison with the coarse crime of constipation, a pill is a peccadillo. Moreover, the only means by which purgatives can be physiologically resisted is by rendering them unnecessary, and the only way of doing this effectually is by dietetic means. The poisons which are paralysing the intestines must be arrested at their source, which is the trencher. They are produced by a plodding perseverance in surfeit of unsuitable foods, and until this practice is replaced by one of moderation in foods which are simple and suitable, the stasis will continue, in spite of abdominal belts, abdominal operations, and abdominal lubricants.

Besides man, the only constipated animal is the domestic dog; and he is constipated from exactly the same causes as those which determine constipation in his master. For purposes of cleanliness, he is taught to control his desire for evacuation; and he is given food, 'the same as we 'as ourselves,' which paralyses his intestinal activities. Of the two, however, the dog is in the better case; for he knows when to fast, whereas man does not.

There are more constipated people in the world than know themselves to be constipated; there are hundreds who live in the fools' paradise of a very partially emptied bowel. The habitually constipated person is commonly sad. He is sad in spirit and sad to look upon. The muddy complexion, the oily skin, the congested ears, and the malodorous emanations, are but a few of the stigmata which proclaim the hidden cesspool to those who know. And those who consent to display these horrors will complain to the doctor that they are martyrs to constipation—for they love to talk about it. The drunkard might with equal justice claim to be a martyr to delirium tremens. The cure for constipation is to eat wisely and not too well; to take plenty of active

outdoor exercise; and to drink pints of water every day; a simple prescription which is easily within every one's reach.

It is to be remembered that the blood-vessels, the arteries, which carry the blood to these excretory organs are necessarily subjected to the influence of the poisons which they carry there for disposal. One would therefore expect the arteries themselves to give evidence of degenerative changes before there is any obvious involvement of the emunctories. And such is often found to be the case. The old saying that a man is as old as his arteries has a special application to the arteries which supply the kidneys and the lungs and the nobler organs generally, because the poisons are delivered to these organs at what may be called nozzle intensity. The peculiar importance attaching to the condition of these organs and their associate arteries at middle age is that there is now still time in which to redress an adverse balance by limiting the supply of toxins and dealing actively with those which have already accumulated.

If a man is to avoid poisoning himself or is to mitigate so much of the process as may be inevitable, it is obvious that one of his principal preoccupations should be the nature of his intake. The two paths of intake are of course the air-passages and the gullet. In these days it fortunately is no longer necessary to insist upon the virtues of fresh air, theoretically at any rate. It is, however, only too true that the theoretical as opposed to the practical acceptance of the faith is still very much in the ascendant. Like the Scotch lady who spoke of love 'in the abstract,' the majority of people are content to pay lip-service to the principle while reserving to themselves a right to parsimony in the practice. People live and sleep behind hermetically sealed windows because they are afraid of draughts and chills. It is at middle age that people begin to dislike cold influences, and unless the dislike and its insidious nature are recognized it is all too easy to slide down the hill which leads to closed windows and stuffy rooms, especially in these days of centrally heated houses. A fully opened window in the night season should always be insisted upon. In the daytime such a thing is often difficult to obtain without a fight, but every man of forty should always bear in mind the paramount necessity for the purity of the air that he breathes, and for the cool freshness of the air with which his skin comes into contact; for he is at the parting of the ways, and the easy path is the wrong turning.

Diet

In the matter of the intake of food, the most difficult lesson for the middle-aged man to learn is by far the most important, namely restraint in quantity. The habit of large meals acquired in the period of youth

and muscular activity is looked upon as a matter of course; any suggestions as to lessening the amount are regarded with surprise and indignation. The ideal of keeping up the strength should give way to that of keeping down the weight, and this can only be effected by a serious attempt to lessen the sum total of the intake, as, for example, by the reduction of lunch to a bread-and-cheese minimum and the total abolition of afternoon tea. The question of the quality of the ingested food is, of course, of very great importance.

The very worst kinds of food are those which are nowadays habitually and generally consumed in large quantities by almost every adult and middle-aged person. These are the sticky foods represented by starches and sugars. At breakfast they are present as sugar added to tea or coffee; as bread, biscuits, and marmalade. At luncheon they appear in milk puddings and jam rolls. At afternoon tea there is a perfect orgy of them; they riot in bread and butter, cakes, scones, and buns. At dinner they come as tarts, either of fruit or jam, with a liberal allowance of bread between the courses. The intervals between these ascetic repasts are frequently relieved by chocolates, fondants, and various other kinds of sweets. It is computed that, on an average, each person in this country consumes between ninety and a hundred pounds of artificial sugar per annum; a quantity which represents a great excess over the moderate amount designed by Nature for our use. That amount may be estimated from the fact that our sweetest fruits contain a surprisingly small amount of sugar, and even this in the form of the easily digested fructose. Thus, cherries contain 10%, apples, pears, oranges, and apricots 8%, raspberries 7%, and strawberries 5%. Even the subtropical grapes and pine-apples contain, the former no more than 17%, and the latter 13%. What more powerful indictment than these facts supply, would it be possible to bring against the present-day practices of middle-aged people in the matter of sugar?

The gravamen of the charge which is often and quite reasonably urged against butcher's meat rests on the fact that the beasts from which it is derived are in an artificially induced state of fatty degeneration, that is, of serious ill-health, before they are killed. For this reason, if for no other, it is easy to draw a definite line of demarcation between butcher's meat on the one hand and fish and game on the other. Birds and fishes have been leading healthy lives up to the moment they are killed, and there can be no doubt that, eaten on the day on which they are killed, that is, when post-mortem decomposition is at its minimum, they do very little harm to healthy active people.

Many of the common foods, meats, sugars, and starches, having been placed in an *index expurgatorius*, it might reasonably be asked what forms of food, outside the index, can be considered as at once suitable to human consumption, and adequate to the primary and essential work

of repair upon which continued life depends. In reply to this, let us recall that the foods in the index are artificial foods, and that the foods proper to middle age are what are often called 'natural' foods. Natural foods are represented by dairy produce, uncooked vegetables, and uncooked fruits. Admitted into the category, but not as full members, are suitably cooked vegetables, dried fruits, bread, and biscuits. Game, fish, and poultry are included under a mild protest, for it must be admitted that whatever may be said against these on some grounds, the liver of birds and the roe of fishes contain valuable elements, even when cooked. Oysters, when taken raw, may claim full membership; cooked shell-fish, honorary membership only. Out of such a list it should be easy for the most exacting person to frame a scheme of living entirely satisfactory both to his physiological needs and to his aesthetic requirements. The term 'dairy produce' includes everything which a dairyman sells: milk, cream, butter, cheese, eggs, and honey; and 'uncooked vegetables' include a great many things which are not usually put into salads, such as carrots, turnips, dandelion leaves, nasturtium leaves, sorrel, thyme, cabbage, horse-radish, and cauliflower. Many of such vegetables are usually cooked, and people often express astonishment at the suggestion that they can be eaten raw. Not only can they be taken raw, but they can be so taken with great advantage, for they are often far more palatable in that state than when they have been cooked. Peas and brussels sprouts are good and useful, even when cooked. Leeks and onions may be taken cooked in the ordinary way. Potatoes should be cooked, and eaten in their skins, as many of their most valuable constituents lie just within their outer coating.

Fresh fruits, which are *par excellence* Nature's foods, should form a large element in every meal. There is nowadays no difficulty in finding a variety of these even in winter, because oranges, bananas, apples, and other fruits are largely imported into this country. Fresh fruits should take the place which puddings now unfortunately occupy in the ordinary dietary. Fruits contain sugar in a readily digestible form—indeed, the only digestible form—and mixed with cream they supply the palate with all that puddings can properly be expected to supply.

Eggs may be taken raw in a salad dressing or other sauces, or they may be poached and taken with vegetables. The longer an egg is boiled the more surely are its vitamins destroyed.

To enter now into detail. Breakfast should be of the continental type; that is, tea or coffee, toast and butter, and some fresh fruit. Compared to the stupefying meal with which the ordinary Englishman considers it his bounden duty to begin the day, this may seem unduly meagre. But, apart from the fact that it is the rule among continental peoples, which is eloquent as to its sufficiency, there is physiological

warrant for the practice. The morning is essentially the period of excretion, and the gastro-intestinal canal should be given as little fresh work as possible in order that energy may not be deflected from its legitimate channels. A glass of water on waking aids the metabolic work; anything over and above that tends to retard it.

Luncheon is usually taken in this country at half-past one. With a light breakfast, half an hour or even an hour earlier is more suitable, though the exact hour matters very little; it is mainly a matter of habit. And, like breakfast, in comparison with the ponderous meal which the well-to-do Englishman takes about midday, luncheon should be relatively light. An egg dish, a salad, some toast with butter and cheese, and plenty of fresh fruit of all kinds, is quite sufficient for most people. If the 'sweet tooth' becomes clamorous, then in addition to the above, some honey, or, under pressure, some jam, may be conceded, to go with the toast and butter. In winter, a cooked green vegetable—say spinach—with an egg, or an omelet *aux fines herbes*, may be looked upon with indulgence. This meal may profitably begin with a glass of water: cold douches should not be restricted to the exterior of the body. Tea and coffee are both agreeable stimulants, but inasmuch as both retard digestion, they are better avoided. Alcoholic drinks, even cider, if taken at all, should be reserved for the meal which is taken when the day's work is done—'No drinks before dinner' is an admirable rule at middle age.

Of the meal called afternoon tea it is difficult to write in terms of suitable restraint. The assemblage of concentrated indigestibles which is ingurgitated into the rebellious and still partially distended stomach at this wholly unnecessary meal, represents a waste of energy, material, and money, for which no excuse can possibly be found. The French, who lunch earlier than we do, never take it; thrift, and respect for the evening meal, combine to keep them in the paths of wisdom. People will sometimes assert that if they don't have tea they suffer from a 'sinking feeling' in the pit of the stomach. This is quite likely, because the feeling of which they complain, and attribute to hunger, is in reality a form of indigestion, for which the proper treatment is not tea, but muscular exercise.

It is found by the majority of people that it is best to defer 'the meal of the day' to an hour when it may be taken untrammelled by business calls and worries. And this plan is entirely in accordance with physiological principles. Leisure to eat slowly, and a mind free from the pressure of engagements, especially if these can be accompanied by congenial companionship, constitute the most suitable atmosphere for appetite, digestion, and assimilation. From among the suitable foods which have already been enumerated or indicated, it ought not to be difficult even for the most exacting gourmet to frame a menu which

would be entirely satisfactory. Fish and a salad; a bird with a green vegetable; toast, cheese, and fruit, varied by some of the etceteras, such as chicken's liver and cod's roe, already mentioned, ought to satisfy any one. It is not that these etceteras are in any degree necessary. Their mention is merely to show that a rational diet is in no sense a faddist or a starvation diet. For the majority of people much simpler fare will suffice. Provided that the meal rigidly excludes puddings, cakes, and other sweets, limits butcher's meat, and generously includes uncooked salads and uncooked fruits, with a suitable quantity of dairy produce, there is a wide choice for the remainder. This applies to healthy middle-aged people who wish to keep fit. Unhealthy people who want to get well are in a different category.

It is a good general rule which bids us to eat sparingly of the things that we enjoy. A well-known physician who has retained his mental and physical efficiency up to a very advanced age attributes his good health to the fact that he has always risen from every meal feeling that he could sit down and eat it all over again. That, no doubt, is a counsel too near perfection for general application to the ordinary man of middle age, but it contains more virtue and much more common sense than the Victorian trencherman's pious practice of eating as much as he possibly could. He constricted his neck with white chokers, and choked his stomach with meat. It is no wonder that he was a hypocrite who died young.

The digestive organs, like the body as a whole, have need of certain periods of rest. In the modern scheme of things, these organs, so far from being permitted to rest, are driven full steam ahead for the full twenty-four hours, and in most cases the safety valves are wadded round and about with adipose tissue.

Fasting

It is a great pity that fasting has gone out of fashion. For the middle-aged it is an excellent occasional discipline. By fasting, is meant complete abstinence from everything except water during a specified period. The process has been referred to elsewhere, but a more detailed regime is given here. To obtain the maximum benefit from this ordeal, lest absorption of deleterious matters should take place from the intestines, the fast should be preceded by purgation. A dose of grey powder at night, followed by a dose of Epsom salts the following morning, will do all that is necessary. As soon as the desired result is obtained the fast begins. While it continues, nothing but water with bicarbonate of soda (two teaspoonfuls to a pint) must pass the lips, and smoking is not allowed. The length of its duration

depends upon many considerations, into which it is impossible to enter here; suffice it to say that a moderate fast should extend over three full days. If the intestinal canal is really empty, the ordeal is by no means as fearsome as it seems, in anticipation, to be. On the first day there is a certain desire for food at the hours of the customary meals, but the desire soon passes, especially if mind or body, or both, are fully occupied. On the second day the desire for food is sensibly diminished, and on the third day one usually has no desire for food whatever. During this period of three days the faster must not pity himself. He must go about his usual business in the ordinary way and take moderate exercise. The process cannot be described as stimulating, but it is much less depressing than one might imagine. One feels well, but as a rule rather sleepy, and there is no reason why the desire for sleep should not be indulged. On the fourth day the fast is broken by a very small meal, say two apples and a cup of tea or coffee. The two other meals of that day should also be very small, and of the raw fruit variety. On the fifth day, the ordinary way of life is resumed, with a feeling of rejuvenation and added zest.

In the case of people over forty years of age who are obliged to lead sedentary lives, a fast of this kind may profitably be undertaken every three months. Some people prefer more frequent fasts of shorter duration, but experience goes to show that the full benefit of abstinence is not forthcoming from a fast of less than three days' duration. The effect of fasting is to cause the organism to live on its reserves. The reserves, in the case of most people, consist of superfluous fat and a great deal of partially assimilated material. The individual is not starving in a physiological sense, because he is living on material which he has been unwittingly putting by for a rainy day. In ordinary modern conditions the rainy day never arrives, and the useless material goes on accumulating. It is therefore necessary to produce the rainy day artificially. When this is done, there is a sort of spring-cleaning of all the tissues, and the machine starts work with all its bearings freed from grit and the fires burning brightly. Fasting is a sensible, harmless, physiological, and inexpensive method of keeping in good health; and one of the most potent means of redressing the balance when things go wrong. It is Nature's way.

Clothing

The general principles of sensible dress, already discussed, are as applicable to the middle-aged as to the young. As the body's reactive power lessens, however, a little more protection from extremes of temperature is called for, but the evils of over-coddling must not be disregarded. Most people speak as though some materials, such as

fur and flannel, were capable of imparting warmth to the human body. This is a mistake. No material is warm of itself. All the heat comes from the surface of the body, so that the action of the 'warmest' material is merely that of preventing the escape of the surface heat. But in the case of a complicated organ like the skin, it is impossible to modify one function without bringing about corresponding modifications in the others. If, then, the heat-regulating function is interfered with by obstructing loss of heat from the surface, it also means that cold influences fail to reach the integument; nerve-messages become sluggish, arteries and veins fail to contract normally, and the blood, instead of being driven inward, tarries on the surface to increase perspiration.

It is thus obvious that the admittedly necessary interference of heat regulation by clothing must be very nicely adjusted to the real needs of the individual and his environment. From late childhood to early adult life the interference should be as little as circumstances will reasonably permit. The healthy young human animal has his own boisterous methods for keeping himself warm; and however noisy and distracting to his elders these methods may be, they afford no excuse for the present system of swaddling and coddling him into silent inertia. But it is with the advent of self-indulgent middle age that the real trouble begins. The period of the bald head and the bulging abdomen is also the period of the long-sleeved woollen vest and the long-legged woollen pants, reinforced peradventure by a double-breasted chest-protector, wrought of red flannel; mystic and actinic.

In the light of what has already been said it should require very little imagination to realize what over-clothing carries with it in derangement of the cutaneous functions and the consequent diminution of resistance to disease, not in the skin only, but in all parts of the body. The superficial vessels never being cooled by the natural method of cutaneous exposure, this necessary function is thrown upon the only other organs whose blood-vessels are brought into direct contact with the outside air, namely, the respiratory organs. This extra work has too often to be performed by them in an atmosphere, not cool and fresh, but laden with warm gases and moisture, for many people dread fresh air more than they fear the devil. The result of this combination of senescence and stupidity is inflammation of the air-passages which, in slight degrees, is euphemistically described as a chill; or, in severe manifestations, as a catarrh or a bronchitis. In explanation of these afflictions it is useless to invoke the microbe; the microbe does not flourish in air-passages until they have been rendered unhealthy by performing tasks which are properly the work of other organs. Once more let us remember that it is the soil that matters even more than the seed.

The same applies to the other viscera and their derangements. The blood which should be busily flushing the brain to promote intelligence, and gaily coursing through the liver to promote cleanliness, is held a languid prisoner in the cutaneous vessels by sodden woollen garments, with the natural result of somnolence, lethargy, and stupidity; with indigestion, constipation, pyorrhoea, and a host of those minor miseries which are usually attributed to the caprice of a jealous God.

The proper purpose of clothing, then, is not so much the promotion of pleasant over-warmth as the avoidance of paralysing degrees of cold. The line between the two is—at first at any rate—admittedly rather fine. But the constant cultivation of 'comfortable' conditions is a degenerate and dangerous practice. As with morphia, the inevitable tendency is gradually to raise the standard and increase the dose, until the point is reached where all degrees of cold become intolerable. This tendency should be kept well in mind, and every effort should be made to resist it. Self-coddling is one of those bad habits which grows with what it feeds on. For this and other reasons it is a great pity that the fashion for cold baths has died out. The morning hot bath dilates the cutaneous vessels, and thus renders the call for 'warm' clothing more imperative. The whole surface of the skin should be exposed, if not to cold water, then certainly to cold fresh air, every morning. It is only thus that the contractile power of the vessels can be kept in training, and the skin itself in a state of 'tonus.' The man with an elastic skin enjoys the cold; he finds it stimulating mentally and physically; it is only the individual with the skin which constant coddling has deprived of its reactions who dreads it. If there were more cold bathing there would be less face-lifting.

The most serious offence against science and common sense in clothing is comprised in the word 'constriction.' Constriction interferes with the circulation of the blood and lymph, with nerve messages, with muscular contraction, and consequently with movement. When applied to accessible organs, as in the abdomen or neck, it embarrasses their functions and impedes the working of the whole economy. All are familiar with the discomfort arising from tight garters and tight sock suspenders, but not every one realizes that such constrictions may be the sole cause of general fatigue and irritability, and that they are often responsible for varicose veins and ulcers; yet such is emphatically the case. If a region of the body were to be sought out in which even a moderate degree of constriction would do the maximum of damage, that region would certainly be the neck. Here we find together some of the most important anatomical structures in the whole body: arteries, veins, nerves, glands, air-passages, closely packed, and readily accessible from without. It is no wonder that our mid-Victorian forbears with their high 'chokers' died prematurely of apoplectic self-satisfaction.

In the matter of clothing, then, coddling and constriction are the two great enemies to fitness and efficiency. When they go hand in hand, as they frequently do, the stage is set for a tragedy, which, though long drawn out and uneventful, is sad because it is stupid. All that is necessary to avoid it is a little courage and common sense. Courage to face and to cultivate a certain amount of cold; and common sense in declining constriction. It is a hopeful sign that the younger generation of both sexes seems to show a taste for freedom in dress as well as in other social habits.

Failing Eyesight

Among what may be called the normal accompaniments of middle age, none is more significant than failing eyesight. The sight for distance remains unimpaired, but bit by bit near vision becomes more difficult until the daily paper must be held at arm's length if the letters are to be clearly deciphered. The disability is quite easily corrected by suitable glasses, best prescribed by an experienced ophthalmic surgeon, who is capable of detecting and correcting any other visual defect, such as a slight astigmatism, the presence of which is liable to complicate the situation. There is another reason why a medical ocular expert should be given the opportunity for examining the retina of the middle-aged, which is that the retinal artery is the only artery in the body which can be seen under ordinary circumstances, and the condition of that artery as revealed by the ophthalmoscope may afford invaluable information as to the state of the arteries in the rest of the body. A perfectly normal eye is not easily overstrained, but perfectly normal eyesight is as rare as a perfectly straight nose. When there is an uncorrected visual error, an amount of work which is harmless and indifferent to the normal eye becomes a real penance, not only to the abnormal eye itself, but to the nervous system of its possessor. Eye-strains of all degree are capable of imposing much misery of various kinds upon all sorts of people. A skilful refractionist can be a veritable saviour in such circumstances, and may lift and clarify the whole outlook on life.

Deafness

Another tell-tale signal of the enemy's passage, and a very sinister one, is deafness. It is sinister because, unlike ageing sight, the impairment of hearing, which is liable to come at middle age, is often incurable. It can, however, frequently be arrested, the method of arrest being not by applications to the ear itself, still less by operations, but by a close attention to such rules of healthy living as will stop the supply of the poisons which cause the mischief. None of the degenerative changes of

middle age is more surely due to toxins than the progressive deafness which afflicts so many relatively young people. Ringing or singing in the ears is a very common accompaniment of deafness, though it may and often does arise independently of any defect in hearing. Subjective sounds of various kinds are often heard by people at the beginning of deafness, and they give rise to much annoyance.

Singing in the ears is often associated with giddiness, of which it is only one of many causes. The ocular troubles just referred to are probably the most common cause of vertigo, though digestive disturbances and arterial derangements are certainly also common; whilst among the many counts in the indictment against tobacco, its power to provoke giddiness must be given a high place. A giddiness which cannot be 'placed' is almost certainly stomachic. It is said that the impairment of hearing which comes with middle age comes more frequently and definitely to town-dwellers than it does to their country cousins. Deafness is, indeed, regarded by some as an automatic protective measure for enabling the nervous system to escape from the over-stimulation which loud noises impose, such as those which in towns emanate from motor engines and horns, and road drills. It is true that a measure of deafness is an advantage to such as attend public dinners and other functions, of which oratory forms a part.

Skin Troubles

As a man progresses down the hill he shows evidences of his decline in the skin and its appendages. The integument tends to become dry, perspiration is scarce, and, owing to the lessening of the skin's elasticity, wrinkles multiply and deepen. The hair of the head becomes grey, because pigment is no longer formed, and ultimately white because the individual hairs are invaded by air bubbles. The factor which decides the greying of hair is not known. Some people retain a full measure of colour into advanced old age, whilst others become quite white-haired in the thirties and even the twenties. Sir Thomas Browne, the sage of Norwich, says: 'Hairs make fallible Predictions and many Temples early gray have outlived the Psalmists Period.' Bacon says: 'Hasty grey hairs without baldness is a token of long time; contrarily, if they be accompanied by baldness.' Baldness is thought by many to be due to a want of stimulation of the roots. Our forbears who wore their hair long rarely grew bald. To keep it clean and in place, short hair, in comparison with long, requires very little brushing and combing and drying, all of which stimulate the roots. When baldness threatens, massage, brushing, combing, and rubbing should be practised diligently. So also should washing; with frequent firm friction with the finger-tips to loosen and supple the scalp.

ECZEMA.

One of the chief skin troubles of middle age is eczema. It is usually attributed to gout and is often caused by dietetic imprudences. The two situations which it seems to favour are the ear passages and the anus, but it is by no means confined to these. Wherever situated, it is very irritating, and much trouble frequently results from the inevitable scratching during sleep. The only reference to treatment which is called for here is the warning that eczema of the kind referred to is always aggravated by the use of soap; and that when it appears in the ear, powders as dressings are much better borne than ointments.

FURUNCULOSIS.

Another common skin affection of middle life is furunculosis, that is, boils and carbuncles. Boils attack any part of the body except the palms of the hands and soles of the feet, but they have a special predilection for the back of the neck, the armpits, and the hips. The causes of these very troublesome and painful eruptions are by no means easy to ascertain in any individual case. One thing at any rate is certain, that they are due to a blood-poisoning, and that the poison in a vast number of cases comes from the digestive tract. Boils are not due, as used to be supposed, to 'a poverty of blood'; they are due to impurity of the blood. A great deal of unnecessary suffering is commonly inflicted upon victims of this painful complaint by the fact that almost every one—layman or doctor—wants to 'squeeze' a boil. Such barbaric treatment not only fails to do any good, but must of necessity do harm. An important thing to remember is that boils and carbuncles are often due to sugar in the urine—are, in short, a sign of diabetes. For this reason a skin manifestation of this kind must always be regarded with suspicion, if not with anxiety, and an appeal to a competent physician should be made without delay.

The Menopause

Inasmuch as the period about middle age has a special significance for woman, it seems advisable to refer briefly to the phenomena of the climacteric or, as it is called, the menopause. The most obvious feature in the change which takes place in most women between forty and fifty is the irregularity and ultimate cessation of the monthly period. This is a sign that the reproductive life of the individual is at an end; she enters upon an entirely new and, to her, strange phase of life in which her character and outward seeming often undergo very considerable changes. The physical alteration is, usually, but not always, in the direction of obesity; whilst in the character there is sometimes a

lessening of the female traits; in extreme cases, to the point of becoming definitely male in outlook and manner. The transition from the one state to the other is often unpleasant, not seldom it is very stormy. The brunt of the trouble falls upon the nervous system, which, especially in childless woman, is liable to be seriously disturbed. It is unfortunately quite impossible to say when the menopause will begin, how long it will last, and what form it will take—whether it will 'pass in the night', as the saying is, or whether it will bring with it a devastating physical and mental storm protracted over a span of several months, possibly of years. The main hygienic point to remember about the phenomenon is that it indicates not only an end of the reproductive power, but what is equally important to the individual health, it means a definite reduction of activity in certain important endocrine glands. Women past the climacteric sometimes become subject to diseases such as rheumatism, and other toxic states, from which they may formerly have been immune. If this fact is borne in mind, there is little difficulty in realizing the danger of 'feeding-up' at the climacteric. The way to keep up the strength is not by loading oneself with material which one is unable to excrete, but by helping to purify the blood stream so that the toxins may not reach the already sorely-tried nervous system. Such are the nervous disturbances at the menopause that many women fly to drugs and alcoholic drinks to tide them over their difficulties. Such drugs as aspirin and bromides are harmless enough in themselves, and often do give considerable relief; but they should be used with caution because, like all sedatives of their type, they tend to lose their effect. This too often leads either to increased dosing or the change to some drug which is not so harmless. Wines and spirits serve in a very special way to relieve the symptoms of irritability and depression and are therefore very liable to abuse.

VI—OLD AGE

Have you not a moist eye, a dry hand, a yellow cheek, a white beard, a decreasing leg, an increasing belly? Is not your voice broken, your wind short, your chin double, your wit single, and every part about you blasted with antiquity? And will you yet call yourself young?—*King Henry IV*, Part II, Act I, sc. ii.

THE above classical description of the unmistakable signs of the onset of old age (addressed by the Lord Chief Justice to Falstaff) comprises most of the physical evidences which proclaim the advent of the last phase, but Shakespeare makes no attempt, either in this passage or another, to indicate the numerical age at which these symptoms may be expected to appear. There is, in truth, nothing in our present knowledge, or very little, which explains to us why it should be that of two men who start life's journey on substantially equal terms, one should last in vigour till eighty, while the other peters feebly out at fifty. The answer to the enigma would almost surely be found in the circulatory system.

THE CIRCULATORY SYSTEM

The saying that a man is as old as his arteries is quite correct. An American has put it more graphically by saying that long life is due to good tubing, and he goes on to remark that the grade of tubing is a matter of heredity: that is why longevity seems to run in families. It is not altogether fair to lay the whole blame for degeneration of arteries upon the original grade of tubing, because the quality of the traversing blood must certainly be taken into consideration. If the blood is charged with poisons, those poisons will certainly affect the walls of the conduits, and however good the material of which the walls may originally have been composed, they cannot escape the influence of toxins which have been bathing them for thirty or forty years. There are, of course, many kinds of poison, and those which have a special predilection for arterial walls have not yet been accurately differentiated; but we know enough to be quite certain that the toxins which are comprised under the term gouty and rheumatic, those, namely, which come from improper feeding, from sluggish excretion, insufficient exercise, and lack of oxygen, are those which give rise to premature degeneration of the arterial wall.

THE HEART.

In speaking of the circulatory system people are, curiously enough, apt to leave the heart out of consideration. The reason is that an originally sound heart will respond repeatedly and gallantly to almost anything which is asked of it in the way of muscular strain, so long as it is not affected by toxins or overloaded with fat. The toxins of certain diseases, notably rheumatic fever, tonsillitis, and St. Vitus's dance or chorea, attack the valves of the heart; seriously compromising its efficiency as a mechanical instrument, and impairing its power of response to exertion. The effect of fat is also largely mechanical. The adipose tissue overlies and embraces the essential muscular tissues, interfering with the expansion and contraction of the pumping heart, just as a weight on a man's chest interferes with the expansion of his lungs. The circulatory system is thus the key system in the prolongation of life, and if it is to receive fair play care must be taken to supply it with pure unpoisoned blood, and to refrain from any possible mechanical embarrassment of the heart by adipose tissue or otherwise. Here is the basis of the saying, already quoted, that fat men don't make old bones.

The Nervous System

Second only in importance to the circulatory system in determining the question of longevity is the mind, with its physical organ, the central nervous system. The man of no occupation, whose thoughts revolve ever in the vicious circle of his own health—what is good for him, how to avoid chills and how to escape microbes—is generally short-lived. It was Plato who said pithily of such people that 'attention to health is the greatest hindrance to life.' Apart from these definite neurotics, there can be no doubt that longevity is influenced by what we still call 'temperament.' By this word our forefathers understood the precise manner in which the 'humours' of the blood were mixed or blended. The theory of the humours, after being smilingly discarded, has now been revised and justified by our knowledge of the endocrine glands; and temperament, or character of make-up, is now recognized as being dependent upon the manner in which the essences of these glands are mixed. Despite its constant use, and not infrequent abuse, of energy, the 'sanguine' temperament which antagonizes all and sundry by questioning all things and contesting all things, lasts longer than the 'phlegmatic,' which believeth all things and endureth all things. Impatience, even when it rejoiceth in iniquity, has a longer outlook than charity. He who suffers fools gladly should not buy an annuity, for nothing kills like boredom. Bacon says: 'They are happy men whose natures sort with their vocations.' An uncongenial mental environ-

ment, such as a nagging wife, is a canker to the nervous system which poisons the blood. The French expression for irritation and annoyance, *se faire du mauvais sang* (to make bad blood for oneself), is literally and physiologically true. Another French saying has a point of application here: *Pour vivre longtemps il faut une bonne digestion et un mauvais cœur*—to live long you require a good digestion and a callous heart—that is, a disposition which is not over-susceptible to moving influences, especially a morbid degree of pity and sympathy in sorrow; for over-indulgence of these emotions exhausts the nervous system and wears it out.

The Glands

If we take Dean Swift at all seriously we must conclude that really great age, even with fair health, is far from desirable. To emphasize this point of view he portrays for us the Struldbrugs whom Gulliver found on the island of Luggnagg. These creatures never died; 'they were not only opinionative, peevish, covetous, morose, vain, and talkative, but incapable of friendship and dead to all natural affections. Envy and impotent desires were their prevailing passions.' In these days such people would probably be treated by glandular extracts, which, in the view of many competent physicians, are capable not only of promoting longevity, but also of rejuvenating the mental outlook. A great deal of work has been done in the matter of glandular physiology, but there are still many problems awaiting solution. Meanwhile, the less we dogmatize about the possibilities the better.

The Digestion

The importance of a good digestion in the attainment of hale old age is, of course, axiomatic. In the promotion and maintenance of health food is clearly a prime factor; upon the material with which physiological waste is repaired will largely depend the physical condition of the individual. It is therefore obvious that the efficiency of the digestive organs which elaborate and absorb the reparative material must be so maintained as to enable them to do their work smoothly. The main line of such treatment is to arrange that the ageing organs shall not be called upon to do the work of organs still young and vigorous. The stimulating diet, the highly seasoned meats and highly sugared cereals, should give place to simple natural foods, the fruits, salads, and dairy produce. The change to these will diminish the work of digestion and assimilation and lessen the amount of poison reaching the blood-stream, so that the neutralizing agencies will be given some respite, and the all-important excretory organs no longer be driven at high pressure. This is a matter that often calls for some degree of insistence;

for old people often have a good appetite, and they like a highly seasoned diet on account of its stimulating properties. In this lies the explanation of the fact that when first made to eat simple foods, old people complain bitterly that such things give them indigestion; and it is true. The stomach has become so accustomed to stimulation that in the absence of the usual spur too little gastric juice is secreted, and very real discomfort results. In such cases the education in dietetic righteousness must be gradual.

The Excretory Organs

The slowing down of function which is the main characteristic even of healthy old age is, above all things, to be remembered in connection with the excretory organs. One of the reasons why the senile lung is so prone to bronchitis is that the air-passages are called upon to aid the other emunctories in getting rid of poisons. This being a task for which the bronchial tubes are but poorly adapted, the poisons irritate the passages, with the result that bronchitic and asthmatic attacks are common. People find it quite easy to understand how it is that fogs irritate the air-passages by applying an irritant from without, but the same people are quite incredulous when told that equally irritating poisons come from within. The way to avoid respiratory troubles in old age is so to order the life that the blood carries as few poisons as possible to the labouring lungs, and this can only be done when the ordinary rules of sound simple living are observed; especially the rules of sound dietetics and those which enjoin the open window and the absence of such adventitious irritants as tobacco smoke. This question of tobacco will again be considered later, but here it seems convenient to insist upon the fact that smoking weakens the bodily defences in many organs, and systems, but more especially and perniciously in the organs of respiration.

THE SKIN.

The importance of the excretory function of the skin is very generally belittled; but the action of a healthy skin certainly aids in the work of ridding the system of toxins, and ought therefore to be maintained in good working order as long as possible. The trouble is that in old age the skin loses its elasticity, and becomes smooth, thin, and dry; whilst the little hair glands and sweat glands lessen in activity. If the integument is to be kept in being as an excretory organ, it must be kept in training, as it were, by the alternate applications of heat and cold, by massage, and by exposure to the influences of air and light. This is not to advocate the exposure of the whole body to the sun's rays for long periods. If there is any justification for such exposure in the case of the young and the middle-aged (which is doubtful), there can be no

excuse for subjecting old people to a violent stimulation, demanding an equally violent reaction which they are quite incapable of producing. The lessened cutaneous response to stimuli in old people is shown in their tolerance of parasites. Where lifelong habit cannot be relied upon, very special care is necessary to ensure cleanliness, because the blunted reactions fail to operate the ordinary signals, and no warning is given of conditions which may demand serious attention. The warts which not infrequently develop on old people, especially on the temples, are manifestations of a degenerative process, and it is not wise to interfere with them, for when irritated they are said to show a tendency to become malignant.

One of the most troublesome afflictions of the skin in old age is the itching that often accompanies the atrophy which sooner or later takes place. The irritation appropriately called 'formication' is described as a sensation resembling that produced by a multitude of insects. It is often aggravated to the point of real pain by the warmth of the bed, and causes a great deal of restlessness and insomnia. If those in charge of such a case will bear in mind that the very troublesome symptom is due to atrophy and degeneration in the neighbourhood of the nerve terminals in the skin, the general lines of treatment will become clear. These lines comprise the daily diligent stimulation of the skin by hot and cold bathing, by massage, and by ultra-violet rays, after every care has been taken by laxatives, colonic lavage, and otherwise to ensure that the circulating blood is as free from irritant toxins as is reasonably possible. A useful method of applying a stimulant to the skin of old people is by the regular exercise of the underlying muscles. The absence of fat between skin and muscle which usually obtains in old age means that if the muscles are exercised regularly, gently, and systematically, the skin is, so to speak, massaged from within. This is a method of treating itching and such other cutaneous degenerations as warts, which often yields surprisingly good results. Such exercises must, of course, be regulated in accordance with the strength of the patient, who should be taught if necessary to perform them in bed.

THE KIDNEYS.

The poisons which accumulate in the system are, so far as the most actively harmful are concerned, normally and physiologically expelled by the kidneys. In earlier years the kidneys are very efficient organs, and easily debarrass the body both of the usual waste products of tissue change, and of any extraneous toxins which may have entered. Acute kidney disease, which denotes acute poisoning, is of comparatively rare occurrence; but chronic kidney disease, which denotes slow or chronic poisoning, occurs in its various forms with ever-increasing frequency as the years advance. It has been argued that most of the

circulatory troubles of old age have their origin directly or indirectly in the kidneys. However this may be, it is certain that when the kidneys lose their vigour the process of chronic poisoning puts on pace and gravity. They are by far the most important of the excretory organs, and any signals of distress sent out by them should be given immediate and careful attention. This is a matter which lends emphasis to the wisdom of an occasional, say an annual, overhaul by a competent physician; because the signals of renal distress are not obvious; there is no pain—at most some inconvenience—no rise of temperature, and no disability. Yet an examination of the urine by an expert may reveal considerable mischief, which, though remediable in the early stages, will, if neglected, pass rapidly to a serious issue. There are, for example no outward symptoms which serve to reveal Bright's disease or diabetes at its beginning, but a very simple routine examination of the urine would immediately unmask either.

Another serious condition which is liable to escape early notice is high blood-pressure. This is usually regarded as a derangement of the circulatory system, but in many serious cases it is due to kidney trouble. The kidneys, in common with the other emunctories, have failed to rid the blood of damage-dealing toxins, so the toxins continue to circulate. The effect of this is that the arteries lose their elasticity, and the irritated kidneys lose their power of voiding undesirable matters. The pressure of blood inside the arteries now rises, and the condition known as high tension results. The responsibility of the kidneys for a large measure of unduly high blood-pressure in later life is undoubted. It is the ever-recurring story of undischarged toxins concentrating upon a particular system or organ, to give rise to symptoms which are attributed to primary disease in the organ itself. When furnished with healthy blood arteries and kidneys do not degenerate, and arterial tension remains normal. Owing to causes which are not yet well understood blood-pressure seems to rise with advancing years, and sometimes reaches with impunity a point which in a younger person would justify serious anxiety. It is said that a rough way of estimating the systolic blood-pressure in figures which should represent the ordinary standards is to add the individual's age to the figure 100; so that in the case of a person of twenty years of age the blood-pressure would be 120; at forty years, 140, and so on. This rather rough and ready method is not too inaccurate if the formula is not over-rigidly applied. It may be regarded as reliable enough up to fifty years of age, but one cannot admit as normal a blood-pressure which reaches beyond 160. Such a figure encountered in a person of seventy years of age or over need cause no anxiety, but when present in any one younger—even when as old as sixty—the advice of a physician should be sought. A great deal of unnecessary alarm is caused to old people by the

prognostications and jeremiads of inexperienced people armed with a sphygmomanometer. High blood-pressure is often quite transitory, and in old people very often quite harmless. It is indeed said by some authorities that a high pressure in old people is essential, if not to life itself, then certainly to any reasonable enjoyment of life. Harm is done by uninstructed enthusiasts who try to reduce high pressure with new drugs. The drugs often depress the spirits, whilst the pressure remains high.

The kidneys are liable to suffer from a repercussion of troubles which occur lower down in the urinary tract, in the bladder and prostate gland. The enlargement of the prostate, which may be regarded as one of the chief physical penalties of advancing years, prevents the bladder from completely emptying itself, with the result that the retained urine, acting as an irritant, causes inflammation of a mild but troublesome kind in the bladder. The irritation and inflammation are liable to travel upwards, and involve the kidney. Such a consummation is very much to be feared, and steps should be taken to deal with the condition in its early stages. An enlarged prostate may be suspected when the patient is obliged to leave his bed more than once in the night to relieve his bladder, and when there is a difficulty in beginning the act of micturition. These symptoms seem harmless in themselves, but it should be explained to the patient that if neglected they may lead to serious mischief. The removal of an enlarged prostate is one of the most justifiable of surgical operations, even in very old people.

THE INTESTINES.

So great is the recognized importance of the intestinal emunctory that of any one who has arrived at real old age it may quite safely be said that he can have very little to learn in this respect. And that little resolves itself into such simple advice as the desirability of varying any necessary aperient from time to time, so that there is no danger of a tolerance becoming established. As a rule the preparations containing paraffin oil, of which there are so many excellent ones on the market, suit old people very well. Natural salts, especially those which are compounded of the fruit acids, may also be taken. A very reliable laxative is cascara, which, in common with those just mentioned, has the merit of being free from that tendency to 'after constipation,' which is the defect of so many otherwise excellent aperients. In spite of this latter drawback, which undoubtedly attaches to it, castor oil should be in the medicine cupboard of all old people. In an emergency or as an occasional aid to the 'flushing of the drains' it has no rival. It does its work effectually, for the most part painlessly, and without any sort of danger. Grey powder and calomel are given too freely to old people. They are not suitable household remedies in old age.

Conduct of Life in Old Age

In the general hygienic management of old people, perhaps the most important thing is that they should be kept up to the collar. Their natural tendency to relax and let things slide must be vigorously resisted. Hot rooms, fur-lined coats, lifts, bath-chairs, and such like, must be forbidden save in exceptional cases. The trouble is that people slip into these ways imperceptibly, and that when once a life of semi-invalidism has been established the more wholesome rarefied air of active resistance is very difficult to recapture. And as a rule the tendency is for those about an old person to encourage the hot-house atmosphere. It is the gradual curtailment of bodily and mental exercise which lies at the root of premature decline. Time after time we witness the break-up of seemingly healthy men who had boasted of their independence of bodily exercise. There can be no such independence; for man is an animal first, and thereafter anything which civilization can make of him. His obedience to the laws of animal physiology is an essential condition precedent to his usefulness in any sphere. The kind of exercise most suitable to an individual case will depend upon things too numerous to discuss here; but in a general way it is safe to say that it is wiser to continue with an accustomed exercise, even if it be the rather dull discipline of walking, than to take to a thing which is new and strenuous. It is the fashion to speak of golf as an old man's game. It is certainly a game which an old man may, and probably should, *continue* to play, but it is a counsel of very doubtful wisdom to advise an old man to begin to play it. It can be very fatiguing both to the muscles and to the temper. Games certainly have their place as hobbies, and hobbies of all sorts are worth cultivating by the old, especially such as will give intellectual pleasure combined with suitable exercise in the open air. For such a purpose gardening stands pre-eminent, and even those to whom this delight is impossible should learn and cultivate the habit of botanizing. Bird watching is another hobby which is open to most people, and any one interested in this fascinating pursuit will find no lack of encouragement in the various societies established for research in such matters. The maintenance of cerebral activity in old people is a thing of such importance as to be worthy of much more forethought than it usually receives. Men who are aware that they will be obliged to retire from business at a certain age should make a point of cultivating an interest in some branch of mental activity several years before their retirement actually occurs, so that the loss of their work does not leave them intellectually stranded. Public life, with its interests and controversies, has been the means of keeping alive many people who would otherwise have fallen into mental torpor or dotage. The rust lies in wait in the scabbard.

Sleep

In considering the causes of this tendency to rust in old age some physicians have been very emphatic as to the complicity of too much sleep. Sir Hermann Weber, himself an advocate of strict moderation in this matter (as in all others), quotes with approval Sir John Sinclair, a physician famous about a hundred years ago, to this effect: 'It is proper to add that nothing is more pernicious than too much sleep. It brings on a dullness and sluggishness of all the animal functions and materially tends to weaken the body. It blunts and destroys the senses and renders both the body and the mind unfit for action.' Though this is still true to some extent, it is less true to-day than it was when the words were written; because sensible people now sleep with an open window, whereas in those days not only were windows tightly closed, but heavy curtains draped both window and bed, so that included under the term 'sleep' was, in reality, a fair measure of carbonic acid stupor. A leading physician of a later date, Sir Clifford Allbutt, said: 'If I get less than eight hours I have invariably to make it up during the week or be the slacker for the loss. And I have thought that many men who to my knowledge had stolen hours from sleep to give to work had in the course of years borrowed at high usury.'

The bedstead of an elderly person should be so constructed as to slope gently down from heel to heart. The height of the former above the latter need not be more than four inches. This can be secured by obtaining four-inch wooden blocks from the local carpenter, or by using out-of-date price lists, to place under the lower end of the bed. The upper end may be pillowed to any desired extent. This little expedient eases the work of the heart and circulation, and by keeping the urine away from the neck of the bladder it tends to decrease the frequency of those dreaded exits from the bed in order to make water.

Blunted Responses

The most noticeable psycho-physiological feature about old age is the slow and seemingly dissociated reaction to stimuli of almost all kinds. This should be ever present to the mind of any one who has to deal with old folk. This blunted reaction is particularly apparent in the matter of pain. What in a young adult would amount to excruciating and unbearable agony, such for example as the pain of gall-stone or renal colic, becomes so much reduced in old age as to be often described by the patient merely as a vague discomfort. To this rule, however, there are two outstanding exceptions to which reference has already been made. One is neuritis, which—using the term in its true sense and not as synonymous with neuralgia—is liable in old

people to be exceptionally severe and exceptionally refractory to ordinary treatment. The pains, for example, which so often accompany the incidence or subsidence of shingles cause so much suffering as to compel the use of morphine, a remedy which should not in such cases be withheld without some very good reason.

The generalized itching of old people is often troublesome and irritating in a very high degree, and although not exactly painful, it can, as has been said, be so severe as to deprive the patient of sleep and render every movement, almost every posture, during the day a burden too heavy to bear.

Another and a very serious exception to the rule of blunted response is provided by the enhanced susceptibility to drugs which is the rule with old people. As this is quite the reverse of what one would expect, the fact is one which should be kept in mind by those who have care of the old. Such household remedies as the bromides, calomel, grey powder, and laudanum, while fairly safe in the case of an ordinary adult, may easily become lethal in the hands of an heroic and impatient nurse in attendance upon an aged patient.

Periodical Examination

The desirability of a periodical thorough examination is very marked in the case of old people, however much they may seem to be above medical suspicion. It is a prudent measure for all responsible adults, the blunted response to which reference has been made. The insensitiveness to pain can easily mask a condition which, though curable in its earlier stages, may, if undetected, march rapidly to a fatal conclusion. Even such a serious disease as pneumonia may cause no pain, no cough, and no fever; and there are many other conditions, less dangerous perhaps, but even more stealthy, which only a thorough examination will reveal. Diabetes is one of these.

The blunting of reaction is often very pronounced in the mentality. The memory, while unusually good for events of long ago, becomes less receptive of recent events, and especially bad for names. Memory is one of the things which must not be allowed to rust; it does so very easily, and old people should be warned to exercise the memory as conscientiously as they exercise their muscles. Whether luckily or otherwise, it is a fact that the emotions are less acute in the aged. When people talk about an old man having died of a broken heart they talk nonsense. There are unfortunately no ready means for combating the tendency to mental deterioration which comes with age and relative disuse. Probably the best of such means is a controversial atmosphere; a great many of the well-known competent octogenarians have been statesmen and others who are concerned with

the strife of ideas. In the case of any individual old person, upon the kind of life he has been leading or wishes to lead will depend the most suitable methods of preventing apathy and lassitude. Imperial and local politics may suit some; letters to the local paper, lectures, the secretaryship or treasurership of clubs may befit others; anything, in fact, which keeps the brain well flushed with blood, especially if it necessitates going out of doors, should be encouraged. Indoors, acrostics, crossword and other puzzles, and the like, are very useful. The one thing to be avoided is the somnolent arm-chair by the fireside.

The periodical physical overhaul advocated above should be conducted not with a view to bringing an old man's life into agreement with academic canons, but with the object of warding off probable dangers and discomforts. Violent and drastic changes should not be attempted; it is far better to continue a stupid thing which has succeeded in this individual case, than to inaugurate a wise thing which has never been tried. A very important item in any overhaul is a thorough examination of the eyes by an experienced specialist, for upon the easy working of the organs of sight will depend a good deal of the comfort and contentment of those whose physical activities are necessarily restricted.

The Ears and Nose

Another pair of organs which deserve very careful supervision as old age approaches are the ears. Deafness is the most irritating, as blindness is the most tragic, of the penalties of old age. It is probably true that some of the deafness from which old people are said to suffer is due to inattention, but even allowing for this there remains a number of people in whom some definite impairment of hearing takes place after sixty-five years. When such impairment is accompanied by ringing or singing in the ears, the position is a pathetic one because there is no known cure. A periodic investigation by a really competent aurist would possibly mean that the tendency to increasing deafness and development of singing in the ears might be arrested, but even this cannot be assured. There would, however, be less deafness in age if people in health would give to rubbing, drying, and massaging the ears more attention than the majority now do.

There would certainly be fewer infections of the upper air passages if the same people would be more attentive to the question of the general hygiene of the nose. In old people, because of their blunted reactions, this is especially needful. The microbic invaders entrench themselves before the keepers of the house have roused themselves to the necessity of defence, with the result that a catarrhal condition arises which, beginning with the nose, spreads gradually downward until it reaches

the bronchial tubes, a position from which it is, especially in winter, dislodged with great difficulty. Every old man should be taught to wash the inside of his nose whenever he washes his face. A soapy little finger insinuated up each nostril and moved gently round and round will do all that is necessary in provoking a flow of cleansing mucus, and if it should cause a hearty sneeze or two, so much the better. In towns this little rite should be observed as a routine measure every night and morning. In times of epidemic, during and after railway journeys, in dry weather when there is much dust about, it is well to supplement the soap and water regime by treating the inside of the nostrils with one of the numerous vaporizing ointments now on the market, containing antiseptic oils, specially prepared for this purpose.

The Teeth

Inasmuch as nearly all those who arrive at old age have shed most of their teeth on the journey, the mouths of the aged are seldom such as to call for more than a passing curiosity. It is, however, well to remember that buried stumps may suddenly and without any warning give rise to a great deal of pain, so that an X-ray examination of the sockets should always be made where there is any difficulty in tracing the cause of a facial neuralgia.

Acidity

The most pronounced chemical characteristic of old age is the tendency to acidity. When foods turn acid it shows that the normal chemical balance is upset, demanding a revision of the way of life in general, and of the dietary in particular. The usual manner of dealing with slight degrees of this aberration by taking alkaline tablets, such as soda mints, is a very good one. Indeed, the taking of alkalis of this kind should not be reserved for the cure of symptoms of acidity, because old age may be said to be a condition of chronic acidity, in which alkalis like soda, potash, magnesia, bismuth, and various others, taken under proper supervision, often serve to keep unpleasant manifestations at bay.

General Aspects of Old Age

Since the days of the author of Ecclesiastes (and he was not the first) many profound sayings have been uttered on the various aspects of old age. Some of these are not complimentary, as this from Cicero: 'Great age enfeebles the memory, and yet I have never heard it said

that an old man has forgotten where he has hidden his treasure. He remembers vividly all that interests him. He well knows to whom he has left his land, who are his creditors, and above all who are his debtors.' That, however, is mild in comparison with Dean Swift's characteristically savage contribution already cited.

In another and kindlier atmosphere are Bacon's comments:

Men of Age object too much, Consult too long, Adventure too little, repent too soon, and seldome drive Businesse home to the full Period, but content themselves with a mediocrity of Successe. . . . Age doth profit rather in the Powers of Understanding, than in the Virtues of the Will and Affections.

The following is from Sir James Paget, a great surgeon and scholar of the mid-Victorian period:

It is very difficult for an old man—say for one over seventy and not unhealthy—to observe all the changes which in the passing years are in progress in him. Even in many things which we can feel and see and which are certainly changing in him he may be unable to discern the change. No man over seventy walks with the same pliant elastic step as he walked at thirty or forty; but many, over seventy, I think are not conscious of the change; they see it in others, they cannot feel it in themselves. Any one I suppose discerns the difference in voice and speech in a friend over seventy while he remembers what it was twenty or thirty years before; but to the old man himself I suspect the change is often imperceptible. He does not observe the diminished range of notes or the veiled sound of his S, or worse still, its shrill whistle. It is only when he puts these and the like things to a careful test that he finds the change. He may find it by timing his walks—his full speed may be half a mile less in the hour—or by trying his voice—he cannot reach his former highest or lowest notes or sustain any note as long as he could. And so it is throughout; the change has been so gradual that it is only with care that even the accumulated contrast can be discerned. With such care the changes can be seen, and so can the reasonableness of the diminution of practice. Herein is one of the many things in which the old need education as much as the young do; they need self-examination, self-teaching. The 'I will' is, in many of their designs, slow and hesitating and procrastinating. Their word should be 'I will, now,' and the work should follow instantly.

Here are some further maxims, appended by Dr. (formerly Dean) Inge to an article on 'Old Age,' in 1930.

The tragedy of growing old is remaining young.

The deeds of the young, the counsels of the middle-aged, the prayers of the old.—Greek Proverb.

Your old men shall dream dreams, your young men shall see visions.—Joel.

Old men like to give good advice; it consoles them for being no longer able to give a bad example.—La Rochefoucauld.

But at my back I always hear
Time's wingèd chariot hurrying near,
And yonder all before us lie
Deserts of vast eternity.—ANDREW MARVELL.

Old Age hath yet his honour and his toil.—TENNYSON.

Warte nur, balde,
Ruhest Du auch.—GOETHE.

The Good man feels old age more by the strength of his soul than by the weakness of his body.—SIR THOMAS OVERBURY.

But go thy way till the end be; for thou shalt rest and stand in thy lot at the end of the days.—DANIEL.

PART FOUR

EVERYMAN IN SICKNESS

I—DISEASES AND THEIR CLASSIFICATION

Diseases are not so many separate things, like tables and chairs; but disturbances of bodily harmony, brought about by all sorts of abnormal circumstances, external and internal. Most of the names given to our various forms of illness have an ancient history, dating from days when diseases were commonly looked upon as so many demons that entered into us and possessed us. Medical nomenclature is consequently very confused, and the confusion of terms is responsible for no small part of the muddled thinking about disease which is almost universal among the lay public, and far from absent from professional minds. Probably, it would be a good thing if we started afresh with our classification of physical and mental disorders, basing this on our present knowledge rather than on a blend of that knowledge with the speculative and superstitious guesses of our ancestors. To the modern scientific physician, words like 'rheumatism' and 'biliousness' mean very little. Lots of terms like these are used every day merely as a cloak for ignorance, or an excuse for inertia. If we acknowledged this it would not so much matter; but, unfortunately, we all of us are apt to assume that when we have once attached a label to a thing we have said all that is necessary about it. An example or two will show how confused our grouping of diseases really is. We speak of a person as suffering from tuberculosis, no matter whether the special locale of his disorder be the lungs, or the hip-joint, or the abdominal glands, on the ground that the peculiar agent responsible in each case is a specific germ known as the tubercle bacillus. Yet another patient we describe as suffering from rheumatoid arthritis, because certain of his joints are inflamed; though the causation of such inflammation may cover a wide range. The symptom 'anaemia' we commonly speak of as a specific disease, though every modern doctor knows that, like headache, it may be but one manifestation of any one of a large group of pathologic conditions, running varying courses and having entirely different origins.

More and more doctors are coming to see that it is only secondarily and as abstractions that they are called upon to contemplate the various syndromes, or groups of symptoms, which are popularly spoken of as 'diseases.' They are recognizing that their first task is to deal with, and to investigate, the general disharmony existent in a diseased individual man, or woman, or child. Any method of grouping diseases, as botanical or geological specimens are grouped in museums, is bound

to be more or less unsatisfactory, unless we realize that such classification has been made purely for the purposes of temporary convenience and temporary expediency. The wise physician lays before himself these questions: 'Is this patient confronting me a sick man? If so, where lie his more immediate dangers? Where are the weak points in his armoury; and how best, with my limited knowledge, can I strengthen them? Is his illness due mainly to some abnormality in external circumstance; or to some peculiarity or weakness in his powers of adaptation? Which of these can I counter or support most effectively?' All the doctor's examinations, all his questions, and all his often seemingly irrelevant investigations, have as their object the discovery of facts which will help him to solve these problems. The art of medicine is not just a matter of finding a name for an illness, and prescribing for it some stereotyped remedy. For nearly all forms of illness there are no stereotyped remedies; and it is one of the purposes of this book to disabuse the public mind of the notion that the palliation of bodily or mental disorder can be brought about by the application of tabulated knowledge, such as might be inscribed on a chart, pinned to the door of a domestic medicine cupboard. Only by an understanding of the main principles of human physiology and psychology, and by the employment of an informed intelligence, can we hope usefully to intervene in those aberrations from bodily and mental harmony which we call disease.

II—THE DOCTOR'S TECHNIQUE

When we visit the doctor most of us feel like aliens in a strange land; mysterious things take place, the significance of which we scarcely attempt to fathom; questions are asked the bearing of which eludes us. Yet the more curious of us must sometimes speculate as to what it 's all about, and even wonder whether it is not all so much mumbo-jumbo—the medicine-man up-to-date.

What is it that the doctor is trying to do? What is he trying to find out? What do we expect of him? And what does he regard as his specific task? He feels our pulse; he looks at our tongue; he taps his finger on our chest-wall; he applies his stethoscope to the region of our heart, and to that of our lungs; he adjusts an inflatable bag round our arm, squeezes a rubber ball, watching a moving dial as he does so; and so on. In the first place he wants to find out whether our suspicion that all is not well with us is justified; for many people imagine that they are ill, or are going to be ill, merely because they do not feel happy or content. He wants, also, to find out, and to trace to its origin, any defect in the functioning of one or other of the ruling organs of the body. Has the balance or equilibrium of the body been upset, and, if so, how? Is equilibrium on another level being gradually established, and, if so, should that readjustment of levels be assisted or, if possible, checked and corrected? Is medical intervention in the sequence of events likely to be effective and, if so, at what point of the vicious circle can it be best applied? The state of the tongue; the regularity or irregularity, hardness or softness, quickness or slowness, of the pulse; the blood-pressure as shown by the sphygmomanometer; the sounds of obstruction or back-working through a defect in any one of the valves of the heart; the size of the heart; the dullness or resonance of the various parts of the chest wall when percussed by the finger; the temperature of the blood: all these things have a meaning to the doctor, who, using the fruits of his own experience and the accumulated knowledge of generations of his professional forbears, is enabled therefrom to form some idea of where and how the physiological processes of his patient have departed from the normal.

Only in so far as the doctor has succeeded in forming a just picture of physiological aberration can he be said to have diagnosed a case. For true diagnosis—that is, understanding—does not consist merely in giving a name to the disorder—rheumatism, dermatitis, arthritis, or what not.

Modern diagnostic methods are often much more elaborate than those which every conscientious doctor employs at his first interview with a patient. Where doubt or suspicion arises in his mind he examines, or arranges for some specialist to examine, the interior appearance of the body by means of the X-rays. He has the blood examined microscopically, bacteriologically, or chemically, or possibly all three. Maybe it is expedient to examine the sputum for bacilli, or the stomach contents, to determine their degree of acidity; or the urine, in order to find out if it contains sugar, or albumen, or other abnormal ingredient. Various tests, manual and electrical, may be employed to learn if the nerve mechanism is in order. Elaborate psychological investigations may be carried out to discover some emotional perversion and to trace it to its source. All these findings it is the business of the doctor to put together, and from them to construct in his mind a picture of what has really gone wrong with his patient. Having determined this, so far as his knowledge and opportunity permit, it is his further responsibility to decide what, with our present knowledge, can be, and should be, done to mend matters. Often, unfortunately, what Nature and ignorance have done, the doctor cannot undo; it is then his task to devise means whereby the evil that cannot be cured may, to some extent, be relieved or lessened. This is where experience tells—even more than it does when a doctor is confronted with an illness for which science has placed in his hands a specific remedy. It will be seen how impossible it is, in any but the simplest form of disorder, for the uninstructed layman to attempt to doctor himself. Far more often than not, in his efforts to relieve some outstanding symptom, the amateur is likely to hinder the very forces that are working towards his recovery.

III—THE IMPORTANCE OF A PERIODIC OVERHAUL

If one takes even a general interest in health matters one can hardly fail to recognize the supreme importance of early diagnosis and treatment. Much illness can be traced back to some minor deviation from the path of absolute healthiness, due possibly to the failure to observe fully some simple rule of hygiene. It should be unnecessary, then, to suggest the importance of periodical medical examination, with a view to receiving either an assurance that all is well, or a timely warning of possible danger. In theory, we probably all agree with this, but in practice we very rarely do it. In this country most medical practitioners would say that for a patient to present himself for overhaul when he felt well was almost unheard of, and that his appearance in the early stages of non-acute disease was comparatively rare.

Except perhaps with regard to children we appear to have lagged behind some of our contemporaries in this matter of examination of the healthy for preventive purposes. We may in apparent health present ourselves for examination for some other purpose, such as life assurance, or admission to one of the public services. The fact that many such candidates discover to their surprise that they do not come up to standard is ample proof that absence of appreciable symptoms is no guarantee of a satisfactory condition. In America, some twenty years ago, the leading insurance companies started a system whereby free medical examination from time to time was available for the holders of their life policies. This was done purely as a business proposition, in the belief that it was possible by this means to increase the length of life of at least some of their clients. The results appear to have justified the procedure, for it is being extended. Germany, Switzerland, Japan, and many other countries have followed the example.

It is true that in this country at least two insurance companies have similar schemes, and others give certain aids to treatment, but it can hardly be claimed that the idea of periodic overhaul has been generally accepted, and there is much to be done in bringing its importance before the public. It must of course be realized both by the layman and by the medical profession that an examination of this nature is valueless unless it is thorough. A cursory examination following the patient's statement that he feels well would be not only useless, but dangerous, as it would give a false sense of security. There must be an extensive

examination of the different systems of the body, following a careful inquiry into the patient's medical history. The full and honest co-operation of the patient is also essential. Should he yield to the temptation to secure a favourable verdict by minimizing symptoms and past troubles he would defeat his own object.

For children we do this thing reasonably well, and the theory receives fairly general acceptance. In every district in this country Child Welfare Centres are available where children may be taken not for treatment, but for inspection. If it is found that the infant is failing to gain weight or to take nourishment properly, or that it shows signs of being unwell, or below standard, suitable advice on management is given. Where active treatment is required the child is referred to the family doctor or to a hospital. In this way prevention may be secured in good time.

It is noticed that, as the children reach the age of from two to five years, attendance at the Centres tends to ease off, but efforts are now being made to bridge the gap between attendance at the Centre and attendance at school. When school age is reached the children at State-aided schools come within the purview of the school medical service. In most districts routine school medical inspections are made at entry, at eight years of age, and when the time of leaving school is approaching. Special examinations of delicate children are made more frequently.

In the County of London in 1933, 39% of the children examined were referred for some form of treatment. If one excludes those requiring dental treatment only, the percentage was sixteen. 4% were referred for specialist examination of tonsils and adenoids, but less than half of these required operative treatment. The figures relating to enlarged tonsils are falling each year, showing an increasing avoidance of operation except where it is essential. This is important, as critics of the system often allege that routine medical examination gives rise to unnecessary treatment. Defects of vision are frequently found, and early treatment obviates the risk of continued strain, and of the defect gradually becoming more serious. Early tuberculosis, early heart trouble, rheumatism, and chorea are often detected. Spinal curvature and other postural defects which have escaped the parents' notice are also discovered and treated by remedial exercises.

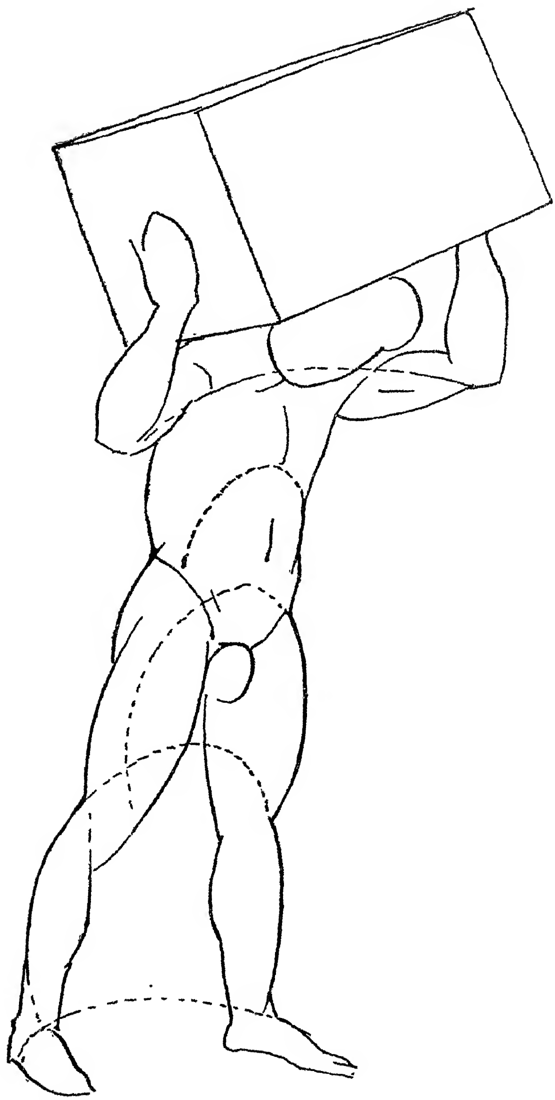
The correction of even minor defects in the developing child is of obvious importance to its future health, but there is no reason why we should stop there. Few of us are so perfectly made that all the different systems of our bodies stand the strains of life equally well, and routine examination applied to the adult, perhaps particularly after forty, may have a notable effect on longevity.

The examination of two groups, each of about three hundred business

men in New York and Boston, gave closely parallel results. Only about one in a hundred had no discoverable defect. Others needed only observation, or instruction in the rules of hygiene. But in 60% of cases defects were found which if uncorrected might affect the length of life. Another 15% fell into a still more serious category, having advanced conditions, which, in some cases, were in urgent need of

The acute diseases usually come in good time to the notice of the physician. It is the insidious chronic diseases which are so often undetected or ignored by the patient, and it is these diseases which could often be held in check fairly easily if treatment were started in time. Many heart troubles, for example, may cause little harm if the life is so regulated that sufficient compensation is possible, and undue strain is avoided. Diabetes is not at present a curable disease; but it can be kept in abeyance with insulin treatment combined with a dietetic regime which has been made less irksome to the patient than formerly. Urine examination may reveal the presence of diabetes, or of imperfect functioning of the kidneys. Blood-pressure estimation may show that old age is advancing more rapidly than it need.

In spite of considerable success in modern methods of treatment for tuberculosis and cancer, these diseases are particularly difficult to bring to treatment in the all-important early stages. To the popular mind these names both suggest a death sentence, and many patients will do their best to conceal symptoms suggesting these troubles. Concealment will not stay the disease, and it cannot be too widely known that if they are detected in time many cases of these two diseases can be cured or at least arrested. Probably nothing would bring these hidden dangers to light so effectively as would routine medical examination, with a determination on the part of patients to learn the facts and to take all possible steps to remedy defects.



THE ARCHES OF SUPPORT

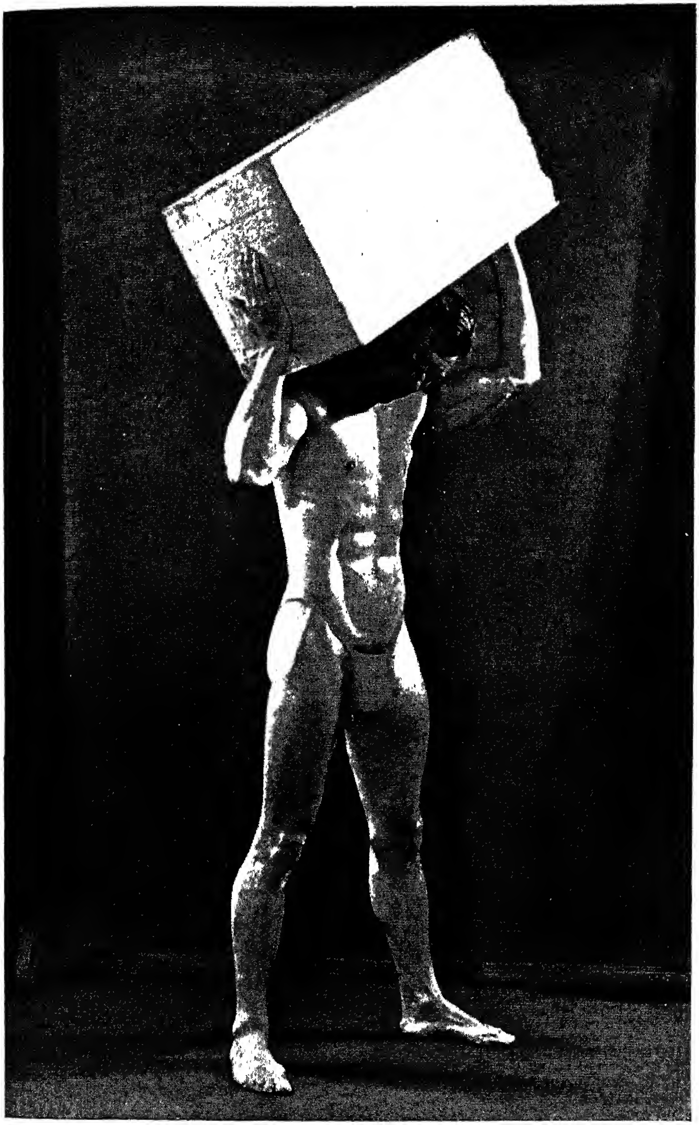


Photo by Herbert Williams

THE ARCHES OF SUPPORT

Shows equal balance on the two feet, with the centre of gravity exactly between them

IV—IMMUNITY, NATURAL AND ACQUIRED

THAT, with or without external treatment, some people recover from illnesses which to others prove fatal, is a fact obvious to every one. This selectivity is not a mere matter of environment, or of worse or better general health; but is, as we say, specific. Some people are relatively 'immune' to this or that disorder, whilst others are in varying degrees susceptible to it. Then, again, there are many diseases—mostly germ-caused—one attack of which prevents its victim, if he recovers, from falling ill with the same ailment again; either for life, as in smallpox, or for a considerable period of time, as in diphtheria, even though he may be exposed to infection. Naturally enough, it has for long been the endeavour of those engaged in medical research to discover the nature of those protective agencies which operate in some people, but not in others. It has been said above that this variation in immunity is specific; that is to say, it applies to a particular disease, or to particular diseases. An attack of smallpox affords protection against a second attack of that disorder; but it offers no protection against measles, or diphtheria, or tuberculosis. It is still an open question whether specific immunity is always acquired after birth, or whether it is to some extent inherited. Almost certainly there is an inherited factor. It is clear that if we thoroughly understood what it is that happens within us to bring about a natural recovery from disease, we should be in a much stronger position for conducting our fight with illness. It is because we have learnt something of these natural recuperative forces, that many of our recent successes in medicine have been won.

Many of the serious as well as many of the slighter diseases that afflict mankind are caused by poisons produced by other living organisms. For the most part these are tiny, microscopic plants or animals, popularly lumped together as 'germs'; though in India, and in certain other parts of the world, the poisons produced by larger creatures such as snakes are responsible for a number of fatalities. The whole world teems with parasitic germs; and, at every moment of our lives, numbers of these find entrance into our bodies. Had we no natural defences against their peculiar attacks, we could not possibly live on this planet; for to avoid them were an impossibility. In this connection the first thing that strikes one is that, from the attacks of many kinds of germs, all men are immune. No matter how much we may be exposed to

potential infection, we do not hear of men catching distemper from their dogs; nor, indeed, do we hear of dogs or horses contracting measles or scarlet fever.

Many diseases, however, are common to more than one species of animal, though the symptoms may be very different. Thus, infection with certain germs provokes in some animals the production of neutralizing substances or anti-bodies identical with and similar to those which a corresponding infection provokes in man. This fact has been made great use of in medicine. Perhaps the best example is afforded by the diphtheria bacillus. Thus it is found that the injection into a horse of the toxin prepared from dead diphtheria bacilli causes its blood serum to be charged with anti-toxins. If some of this serum is drawn off and injected into a child suffering from diphtheria, the child's own resistance is enormously increased. The immunity thus effected is known as passive immunity, to distinguish it from that active immunity which results from the patient's own production of anti-bodies in response to infection. These anti-bodies, whether actively produced or passively received by injection, usually remain in the blood for a variable period of time: and it is found that races, both of men and of animals, can, by repeated attacks of a germ disease, become less and less susceptible as the generations pass. To take a striking example: since the introduction of plague into Bombay in 1896 the rats of the city, at first stricken wholesale by the disease, have annually shown progressively lower susceptibility thereto. Experiments over a period of years show that a given dose of plague bacilli will to-day kill less than one-fifth the number of Bombay rats than were killed by a similar dose twenty-five years ago.

It should be noted that active immunity usually lasts much longer than does passive immunity. In order to bring about active immunization, it is not usually necessary to inject the living germs themselves. It is generally sufficient to inoculate with a preparation of their dead bodies, or of the toxins which they have produced outside the body. In a few cases, however, this has not yet been found effective; but the potential dangers of injecting living disease organisms, whether bacillus or ultra-microscopic virus, are obvious.

The immunizing agent usually tends both to neutralize the bacterial toxin and in some way so to act on the living germs as to make them more readily incorporated—physiologically or pathologically—with the phagocytes. Luckily, the anti-toxic factor can often be provoked into existence by the inoculation of a virus so altered and attenuated as to be incapable of producing the actual disease. Anti-diphtheria serum is thus obtained, and has proved of enormous value both in treatment and in prevention. As already mentioned, the blood serum of a horse, having, consequent on a series of steadily increasing doses of virus,

become heavily charged with the anti-toxic factor, is injected into a susceptible or infected person; and produces in him a temporary 'passive' immunity. So heavily charged with anti-bodies may the animal's blood become that its tolerance for the specific toxin can be increased from ten thousand to one hundred thousand times. The state thus induced in the animal is spoken of as 'active' immunity, and corresponds fairly closely with the immunity brought about by an attack of the disease itself. Prophylaxis of rabies, smallpox, typhoid, and paratyphoid is effected in this way.

Not only passive, but also active, immunity to diphtheria may be induced in susceptible children by the injection of a mixture of diphtheria toxin and anti-toxin. The immunity thus conferred lasts for several years. By a method known as the Schick test—which consists in injecting into the skin an infinitesimal amount of diphtheria toxin, and observing whether or not a redness appears round the injection point—the susceptibles may be separated from the insusceptibles, the former alone needing to be artificially immunized.

Similar tests have been devised for the detection of tuberculosis and of scarlet fever (the Dick test); whilst other diagnostic tests, physiologically similar in principle, are the Wassermann test for syphilis, and the Widal test for typhoid.

V—GERMS AND INFECTION

Germs have been given various names, such as bacteria, microbes, bacilli, and micro-organisms. It does not matter much which word we employ, so long as we know what we mean when we use it. Germs are generally considered to belong to the vegetable and not to the animal world. Yet they live not quite like vegetables nor yet quite like animals. For example, they do not possess chlorophyll, which gives the green colouring to plants; on the other hand, they do not reproduce themselves like animals. Perhaps it is best to regard them as existing on the border line between the animal and vegetable kingdoms.

They are the smallest of living organisms (if we exclude the filter-passing viruses—of which we shall speak later); the width of an average germ being one twenty-five-thousandth of an inch and the length about one five-thousandth of an inch. They can be seen only under the microscope. Each germ is a single cell, but it differs from other kinds of cell in having no nucleus: it is just a minute mass of protoplasm enclosed within a cell wall. In shape germs may resemble very small spheres (cocci), straight rods (bacilli), or curved or twisted rods (vibrios, spirilla). Often the rods become stuck end to end, forming chains or filaments. Some germs have little whips (flagella) at either end, which lash to and fro and enable them to move about; or these flagella may stick out from all sides of the germ.

A germ reproduces itself by dividing into two equal halves, but there is evidence that some form of sexual reproduction does also take place. In favourable conditions multiplication is very rapid, and hundreds of thousands of single cells can be produced in a few hours. The life of a germ is very short, lasting generally less than half an hour. It can live, however, in a sort of state of suspended animation for a year or longer. This it accomplishes by forming round itself a tough envelope which enables it to resist extremes of heat and cold as well as desiccation. The spore of the anthrax bacillus, for example, which causes a deadly disease in sheep and oxen, and can also infect man, must be subjected to dry heat at a temperature of 140° C. for several hours if it is to be killed with certainty. When the spore finds itself in a suitable environment, with the right temperature, moisture, and food supply, it wakes up, throws off its tough resistant envelope, and enters upon a life of unbridled bacterial activity.

Germs exist everywhere—in ponds and ditches, in streams and rivers, in refuse heaps, bogs, and drains, in the soil and in the sea. If any

organic matter is allowed to stand exposed to the air it soon swarms with germs which quickly set to work to break it up. Germs are first-rate housebreakers. Paper, rags, straw, leaves, and wood are decomposed and broken down by the bacteria which attack cellulose, and the decomposition of dead bodies is carried out by others. Thus the elaborate chemical compounds which have been built up during the life of an organism are at death reduced by germs to their original simpler forms, which can once again be utilized by new generations. Chemically speaking, bacteria put the dead body back to where it came from. Their ways of living and feeding are little short of astonishing. They break nearly all the rules which other living organisms have to obey if they are to survive. Many of them can live without oxygen; some, in fact, will die if they are exposed to it. Some get their energy by oxidizing sulphur or iron or ammonia; others, by splitting up organic matter.

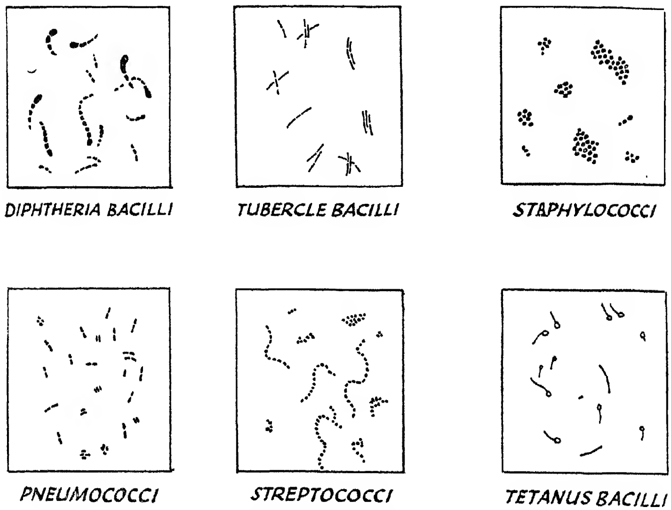
Germs that are Useful

Germs are commonly looked upon as being only harmful and hostile: but such is far from being the case. We have already seen that they perform a very useful function in redistributing the chemical elements of dead organisms and waste matter. In addition to this, bacteria play an essential part in the fermentation processes employed in manufacture; as, for example, in the tanning of skins, in the preparation of indigo, and of tobacco and hay. Bacteria are necessary in butter-making and in cheese-making; but more important than these activities are those exerted by bacteria on behalf of the farmer. Hundreds of thousands of tons of urea are deposited daily in the excreta of animals and man. The manure which the farmer spreads over his land would be of no benefit to the soil if certain bacteria were not able to break down this urea into nitrites and nitrates, and thus make its nitrogen content available to plants. There are bacteria which can collect and 'fix' the nitrogen in the atmosphere. These are found in the nodules on roots of leguminous plants (peas, beans, vetches, etc.), and it has been found that sowing land with these plants leads to a great enrichment of the soil with nitrogen. For this reason leguminous plants are an essential item in the rotation of crops.

The Discovery of Germs

The microscope was invented in the sixteenth century, and has made possible the development of bacteriology, or the science of germs. A Dutchman, called Van Leeuwenhoek, who used to write long rambling letters to the Royal Society of London, in the seventeenth century detected bacteria in scrapings from his own tongue, but it was not

until the nineteenth century that knowledge about these mysterious one-celled organisms began to accumulate. And it was only about sixty years ago that it was definitely known that bacteria had any connection with disease. For centuries it had been realized that disease was contagious, and could spread from person to person, and in time the supposition was put forward that actual infective material passed from one person to another. What this material might be was another



SOME TYPES OF GERMS

and more difficult question. A German physician, Henle, born in 1809, came to the conclusion it was living matter. Finally, the triumphant researches of the Frenchman Pasteur and the German Koch proved once and for all that infection is associated with germs.

Pasteur exploded the myth of 'spontaneous generation' of microbes. He proved that fermentation is a physiological process by demonstrating that the yeast which caused fermentation consists of living organisms, capable of growth and multiplication. He showed that the disease which threatened to ruin the silkworm industry in France was brought about by a germ. He told the wine growers that if they heated their wine to a certain point it would not spoil, as wine 'sickness' was due to a microbe; from this we get the word 'Pasteurization,' applied to a process of sterilization by heat.

When he succeeded in curing patients of hydrophobia by inoculation, the whole world went wild with enthusiasm, and the Tsar of Russia sent him a diamond cross of Saint Anne, and one hundred thousand

francs with which to begin the building of what is now known as the Institut Pasteur.

It was Robert Koch, however, who, carrying on most elaborate research work in spare time snatched from a busy general practice, put the germ theory of disease on a really scientific basis. The conditions which have to be fulfilled before it can be stated beyond doubt that a certain germ causes a certain disease were laid down by Koch. The organism, he said, must be discoverable in the infected animal or man in all cases of the disease; it must be cultivated through several generations on an artificial medium; the cultures must be able to reproduce the same disease when brought into contact with animal or man, from whom the same organism must be again recoverable in pure culture. The work that brought Koch from the obscurity of a general practice to the fame of a scientist with a world-wide reputation was his research on the anthrax bacillus, the results of which were published in 1876. These bacilli he found in the blood of infected animals, and he was able to grow them outside the body. From the culture of organisms obtained in this way he produced the disease experimentally in other animals. Koch also observed the formation of spores in anthrax bacilli. Thus the germ theory of disease was put on the pathologic map.

Koch was soon given a scientific post in Berlin, and he continued to make important contributions to bacteriology. In 1882 he discovered the specific germ of tuberculosis—the tubercle bacillus—and, later on, that of cholera, a germ called the cholera vibrio. He was awarded the Nobel prize for medicine in 1905, and when he died in 1910 he was recognized as one of the greatest bacteriologists the world has seen.

Since the days of Koch and Pasteur the science of bacteriology has gone ahead by leaps and bounds. The fear has even been expressed that the germ theory of disease has lately too much dominated medical thought. While this may be partly true, the benefits gained from those discoveries of little more than sixty years ago have been enormous. The amazing advances of modern surgery have only been made possible by antiseptic and aseptic methods which have gradually been built up on the basic assumption that infection of wounds is brought about by germs. Modern sanitation, the purity of our water supply, and the control of such diseases as typhoid, cholera, malaria, diphtheria, and others, we owe to Koch and Pasteur, and to the workers who followed them.

Methods of Studying Bacteria

We have already mentioned the criteria laid down by Koch for the establishment of a causal relationship between a particular germ and a particular disease; so that it may be asserted with scientific confidence

that, for example, typhoid fever is associated, and always associated, with a bacillus having a definite shape and form and certain constant characteristics distinguishing it from other germs. So it is called the typhoid bacillus. Before the scientist can prove this, he has, first of all, to catch his germ. He has to isolate it from other germs, to bring it up on artificial foods in his laboratory, so that he can study its way of life—how it behaves chemically and physically—and he has to devise various means of making it easily visible under the microscope. He has to establish the identity of the numerous germs that exist, and to lay down standards by which any other observers can distinguish one germ from another.

Koch did some extremely important work in this business of identifying and examining germs. His publications on the staining of bacteria with aniline dyes in order to make them visible under the microscope, on photographing them for purposes of identification and comparison, and on growing (culturing, as bacteriologists call it) bacteria on a solid medium of gelatine and broth, were of the most profound significance in the science of bacteriology.

Artificial Culture of Germs

In growing disease germs outside the body it is evident that their food should resemble as far as possible the kind of stuff they feed on naturally; so it is that coagulated serum of blood is often employed as what is called a culture medium. Koch used this serum for cultivating the tubercle bacillus. It has been found that various media, consisting of proteins or carbohydrates, will support life in most of the disease-producing germs; and meat extract, gelatine, and broth, a carbohydrate substance called agar (which is often mixed with other substances), potato extract, and a variety of other preparations serve as fodder for the germs kept in captivity in the bacteriologist's laboratory. The advantage of having different media is that a particular microbe may grow well on one medium and not on another, and this helps the scientist to identify it. Also, each microbe, as it feeds, breaks down the various substances on which it lives into gases, acids, etc., in such a way as to distinguish it from others. Some microbes, for example, ferment sugars, whilst others do not. Some have a destructive action on blood, and others, again, do not.

Of course, before these media can be used, they must be sterilized in order to kill any bacteria that may already be present in them, otherwise the bacteriologist would not be able to tell whether the bacteria that appeared were those he had put into the media. Koch used to sterilize his media by heating them in steam at 100° C. By sterilizing with steam at high pressure in a special apparatus higher temperatures still

can be obtained. Another method of sterilization is to pass the fluid through a filter whose pores are so small that bacteria are unable to get through them.

The modern technique of bacteriological investigation is, roughly, as follows. Let us suppose that you have a sore throat, and that your doctor wants to find out what germs are responsible for the inflammation of your tonsils. He will take a swab—a piece of sterile wool wrapped round the end of a stiff wire—and rub it against the inflamed tonsil, so capturing some of the inflammatory matter. He will then smear this on the surface of a solid culture medium (say agar or gelatine, contained in a glass tube), which he will incubate at the temperature of the body, that in which the germ is accustomed to live. Within a certain number of hours he may see a whitish round patch on the surface of the medium. This patch consists of the thousands of bacteria which have grown and multiplied, and is known as a 'culture.' The doctor can then take a portion of this patch on the end of a platinum wire, spread it over a thin glass slide, and examine it under the microscope. This is the simple kind of procedure adopted in diagnosing diphtheria; for the bacillus associated with this common disease is relatively easy to identify under the microscope. In various circumstances the doctor may wish to look for germs in suppurating wounds, in the expectoration, in the blood-stream, in effusions of fluid into the joints and the cavities of the body, in urine, faeces, etc. He does this by inoculating different media with these secretions and excretions of the body.

Before the doctor looks through the microscope for the germ, he usually stains it, so that it may be easily visible. This is another of the methods worked out by Koch, who found that bacteria had a marked affinity for aniline dyes. Germs stained with these various colours are much easier to see under the microscope—in fact, one could not see some of the smaller types without first colouring them. An interesting fact is that certain germs have a particular liking for some dyes, and a distaste for others. This provides still another way of differentiating various types.

In the chapter on immunity an account is given of the way in which the body mobilizes its defences against attack by germs. We there learnt that each germ provokes the formation in the blood-stream of anti-bodies specially designed to overcome it. Without going into technical details, it is sufficient to state that this reaction, and others associated with it, can be turned to account by the bacteriologist in deciding whether a patient is infected, or has been infected, by a particular microbe. In a given disease the doctor may be unable to identify the causative germ. If, however, he finds that the anti-bodies of a suspected germ are present in the blood of his patient, then he can safely assume that the germ is present also, although he may not be able to find it. This is, of course, of considerable importance, and is of

great value in diagnosing typhoid, paratyphoid, and syphilis. The Wassermann test for syphilis, which, roughly speaking, is based on the above principle, is one of the most valuable of laboratory tests.

Organisms Smaller than Germs

Do living organisms exist that are still smaller than the bacteria we have just been discussing? The general opinion is that they do, although, as anything smaller than bacteria is still extremely difficult to investigate, we cannot yet determine the truth of the matter with that degree of exactitude which science demands. Particles smaller than the smallest known germs are outside the range of ordinary microscopic vision.

It was observed in 1893 that if the fluid from a blister of an animal suffering from foot-and-mouth disease was passed through a filter the pores of which were too small to let bacteria go through, the disease could still be conveyed to animals from the fluid thus filtered. The process was repeated, and the disease transmitted through a succession of animals. In other words, an infectious disease had been caused experimentally by some 'thing' which was not a visible germ. This infectious poison, or virus as it is called, was given the name of filter-passing virus. One of the filters commonly employed for this purpose is made of unglazed porcelain, the holes in which are so small that bacteria cannot pass through them; the filtrate therefore being free from bacteria. This provides a way of separating the poisons or toxins excreted by bacteria from the bacteria themselves.

With ordinary microscopic methods light is transmitted directly through the material to be examined, and so direct to the observer's eye; but it is difficult in this way to see very thin or very small microbes. It is, however, possible to extend the limits of microscopic visibility by the method known as dark-ground illumination. Here, the illumination is so arranged that the light strikes obliquely from all sides on the material to be examined, and does not pass direct to the observer's eye. Let us suppose this material to be a wet film containing very small particles. The particles will scatter the light and show as brilliant images against a dark background; and, in this way particles smaller than bacteria can be seen. If ultra-violet rays are used as a source of illumination and a camera is substituted for the observer's eye, still smaller particles can be observed. It has been calculated that by this method the form of a particle as small as somewhere in the region of one hundred-thousandth of a millimetre can be determined.

A number of diseases are now known to be caused by the filter-passing viruses. Infectious fluids from patients suffering from these diseases, in which no visible germ has been found to be present, have been filtered,

and the products have brought about the disease in a succession of experimental animals. Quite recently it has been shown that influenza is due to infection with a filter-passing virus. Other diseases so caused are infantile paralysis, mumps, distemper, sleepy sickness, measles, chickenpox, and smallpox. There is every reason for believing that these filter-passing viruses are living organisms, but whether they are just very small bacteria or a different order of living things is not yet known.

One very remarkable discovery has been made in connection with ultra-minute organisms. An Englishman, Twort, and a Frenchman, D'Herelle, have found that cultures of bacteria on artificial media can be killed by some 'thing' which passed through filters, and that this destructive 'thing' can be transmitted from one culture to another. D'Herelle has come to the conclusion that the 'thing' is a filter-passing virus which preys upon bacteria, and calls it bacteriophage (germ-eater).

So in the filter-passing viruses and the bacteriophage scientists appear to have discovered a new kind of living organism, an animal or vegetable, whichever it may be, which is so minute that it cannot be seen by ordinary microscopic means.

Disease Germs

In the last few pages some general idea has been given of the rich and varied life of minute organisms that exist on the borderland between the animal and vegetable worlds, and some of the steps that have been made in the discovery of this life have been traced. But our concern here is more especially with disease, with germs which have found the human body a suitable habitation with a plentiful and abundant food supply—although, if they run their course unchecked, they end by destroying the host that gives them shelter. Perhaps one of the most remarkable features about germ diseases is that they remain more or less true to type, one particular germ causing one particular disease. The typhoid bacillus has a special liking for the intestines, where it gives rise to ulcers. The diphtheria bacillus has a predilection for the throat; the meningococcus for the coverings of the brain. When a germ attacks the body and produces disease the symptoms complained of by the patient and the signs found by the doctor are, in the main, characteristic; and, taken together, they enable the doctor to diagnose with more or less certainty the kind of disease affecting the patient, and the germ which is causing it.

Take the case of pneumonia. The patient suddenly falls ill with a shivering attack and a pain in the chest. He has a cough and breathes rapidly. The symptoms indicate to the doctor that something is wrong with the lungs. Examination of the lungs reveals signs which the

experience that has been handed down from one generation of doctors to another shows to be associated with an acute inflammation of the lungs—a condition to which the name of pneumonia has been given. The researches that have been carried out during the past fifty odd years have proved that this inflammation is most commonly caused by a germ having special characteristics and a life-history of its own, a germ which we call the pneumococcus. This knowledge is of the greatest importance to the doctor, for it makes it possible for him not only to treat the patient, but to take special measures directed against the germ itself by injecting a serum that is specifically 'anti-pneumococcus.'

WHERE DO DISEASE GERMS COME FROM?

The bacteria that cause typhoid and cholera can exist and flourish outside the body, in damp soil, and in water. If they are swallowed in infected drinking water they may give rise to disease. It would appear, however, that other microbes, such as those which, for example, are responsible for venereal disease and tuberculosis, cannot live outside the body; nor are the filter-passing viruses found free in nature. They are obliged to live a parasitic existence. Many microbes find shelter on the surface of the body and within its passages, on the skin, in the mouth, and in the intestines, without doing any harm. They may continue to cohabit peacefully without making their presence felt. Changes may, however, take place in their constitution or in that of the body, causing these formerly inoffensive germs to attack their host. When the general health is below par, boils, styes in the eye, or carbuncles may result from infection with a microbe called the staphylococcus, which is always present on the skin. Dangerous germs like the pneumococcus may inhabit the throat for a long time without doing any harm, but may suddenly become disease-producing for the person in whose throat they live, and for others with whom this person may come into contact. More strangely, some people may carry the germs of disease and infect others without themselves suffering any ill. These 'carriers,' as they are called, may have suffered from a disease and have recovered from it, but may not have got rid of the germ which caused the disease. This happens, for example, sometimes in diphtheria, and in typhoid, when the bacillus is still found long after the disease has disappeared. The danger is, of course, that the carrier, though being a healthy person in fact and in appearance, is yet a source of infection to all with whom he or she comes into contact.

THE SPREAD OF INFECTION.

Germs have many ways of carrying on their species. Infection can be conveyed by water, as in typhoid; by milk, as in bovine tuberculosis;

by air, as in smallpox; by droplets, as when a person with a cold or diphtheria sneezes; by clothes, as in scarlet fever; by lice, as in typhus; by mosquitoes, as in yellow fever; by fleas and rats, as in plague; by direct contact, as in venereal disease. Enough examples have been given to show that germs have explored, as parliamentarians say, every possible avenue that may lead them to a human being on whom they can feed and multiply, and then to spread to still more people. It seems surprising that once an infection has started it does not go on for ever, affecting the whole population of a country. One would think that once a germ had got going the only thing that would stop it would be geographical boundaries.

An outbreak of infectious disease in a community is called an epidemic, and, as there are many ways in which the illness may be spread, so there are several factors which help to keep it within bounds. The problem is a complicated one. Climate, overcrowding, the vitality of the population, the degree of infectivity of the germ, the isolation of infected patients, the tracking down and elimination of an infected food or water supply, preventive inoculation—all these help to modify, in one way or another, the extent of an epidemic. Another interesting feature of infectious diseases is that they change in character; scarlet fever and smallpox, for example, being much less grave diseases than they were thirty or forty years ago. Then there is the mystery of the sudden appearance of new diseases. Syphilis, for example, has no history before the fifteenth century, since when it has spread its ravages to all parts of the world. During the last fifteen years the disease known as sleepy sickness has come on the scene, with its appalling effects on the nervous system. From time to time an infectious illness seems to get the whole world in its grip—a pandemic as it is then called—as happened in the influenza terror of 1918–19, when as many as six million people died in India alone.

THE EFFECTS OF BACTERIA.

When an individual becomes infected by a germ, the latter has various ways of getting a foothold in the body. It may, as in diphtheria, lodge on the tonsils; it may reach the intestines, as in typhoid, or the lungs as in pneumonia; it may enter the skin through a cut, or through the bite of an insect as in yellow fever. While a germ may remain localized, it may instead break through local barriers and enter the blood-stream, there to multiply and carry disease to all parts of the body—a grave condition known as septicaemia. If we cut ourself with a dirty knife the wound may become septic, which means that germs have infected it. If the germs escape from the wound into the blood and there multiply, you have 'septic-aemia.'

The effects of bacteria on the health depend upon the nature of the

infecting agent and the constitution of the infected person. As to the first, the virulence of the germ, the numbers of it that are introduced into the body, and the path of entry it takes are determining factors. As far as the infected person is concerned a number of things must be taken into consideration. The physical and mental well-being, the age, and the social circumstances, of a man or woman will make a difference to the way in which he or she reacts to an illness. Some races are more susceptible than others to certain types of infection. Consumption in negroes is a more serious disease than is consumption in Europeans, while the Irish are more susceptible to this complaint than are the English. Patients suffering from diabetes are very often afflicted with boils and carbuncles, and are abnormally susceptible to tuberculosis.

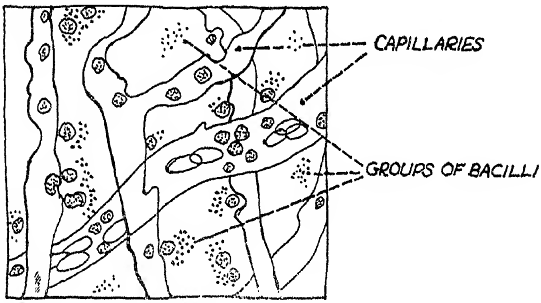
HOW DISEASE GERMS ACT.

Once disease germs have entered the body they multiply very rapidly, and their growth is accompanied by the formation of chemical products which act as poisons to their host. The germs that cause tetanus (lock-jaw) and diphtheria manufacture large quantities of poison which we call toxins, and the serious symptoms of these two diseases are due to these toxins and not directly to the germs themselves. The diphtheria bacillus grows on the tonsils and remains there, but the toxins it produces spread through the body and give rise to the symptoms characteristic of diphtheria: these toxins may paralyse the nerves or bring about heart failure. Other germs do not pour out toxins in such abundance. Their poisonous activity is mainly confined to the particular place in which they happen to lodge and multiply, and many of their manifestations depend upon the particular part of the body attacked. In typhoid fever, for example, the abdominal pain and diarrhoea are due to the formation of ulcers in the intestine.

The chemical poisons that result from bacterial activity manifest themselves in the fever, headache, quickened pulse, feeling of illness, etc., which are characteristic symptoms of most infections. If the bacteria settle chiefly in the brain, then such symptoms as convulsions and loss of consciousness occur; if they settle mainly in the lungs, then the patient will cough and spit and, perhaps, breathe with difficulty. All infections, then, are characterized by certain general effects due to the general action of chemical products resulting from the growth and multiplication of bacteria in the body, and by certain special effects. These latter, as we have seen, depend upon the part of the body attacked, and also upon the fact that certain poisons have special affinities with particular tissues of the body. For example, the toxins of the diphtheria bacillus, manufactured in the throat, have a predilection for nerves, and so often cause paralysis—a paralysis which is fortunately not permanent.

THE REACTION OF THE BODY.

Other sections of this book have dealt with inflammation and the process of immunity, so brief mention only will be made here of these ways in which the body meets invasion by bacteria. The curious thing about the inflammation resulting from such invasion is that bacteria in some way attract those cells of the body which will at once attempt to destroy them. In suppuration, for example, there is an increased production of the small white cells of the blood called the polymorphonuclears; elsewhere, germ-infection calls out the large cells formed in the lymph glands, the spleen, the bone-marrow, and the



EMIGRATION OF PHAGOCYTES

liver. When these cells, large and small, arrive at the site of infection a fight goes on between them and the germs, with heavy casualties on both sides. This fight may be sudden and severe, as in acute inflammation; or it may drag on with rather indefinite results, as in chronic inflammation. The germs attack the cells with their poisons, and the cells engulf the germs—phagocytosis, as the process is called. Inflammation is thus one of the mechanisms of the body for defending itself against invasion by bacteria.

Immunity, as is explained in the section dealing with this subject, is a complicated affair. The immune bodies that are produced in response to infection by germs combine with the bacteria and their toxins, neutralizing them, and preventing them from attacking the cells of the body. Some people have a natural immunity to certain diseases, and go through life without ever catching, say, measles. Other people may acquire immunity by passing successfully through an attack of a disease. With measles a second attack is extremely rare; immunity to it is lasting. In other illnesses, of which influenza is a notorious example, immunity is short-lived, and one may suffer from several attacks within a short time. This property possessed by us of

producing immune bodies forms the basis of the modern treatment by vaccines and serums.

When microbes assault the body and succeed in producing disease the body responds with fever; and by fever is meant a change in metabolism, and a temperature raised above the normal. Whether or not this response of fever is beneficial is disputed, but the reduction of temperature (when not extraordinarily high) by means of drugs does not appear to be very helpful, and is nowadays discouraged by doctors. On the other hand, extreme temperatures of over 103° F. (the normal is 98·4° F.) seem to be detrimental, and attempts are usually made to lower them by sponging the body and by reducing the bed-clothes to a minimum. The metabolic changes that occur in fever certainly do not appear to be of any obvious good to the body. There is a conspicuous wastage of body-tissue, the destruction of proteins being particularly marked. There is interference with the assimilation of food-stuffs from the intestine, and diminished activity of the kidneys. The frequency of the heart-beat and of the breathing is increased. Although the skin is hot and flushed there is typically a lessened secretion of sweat. There may be an increased loss of water by way of the breath, but not enough to compensate for the increased production of heat.

Many fevers start with a severe shivering attack, in which the skin feels cold and looks like 'goose-flesh,' a phenomenon due to the contraction of the blood-vessels, and of the smooth muscle under the skin. This contraction prevents loss of heat, whilst the action of the muscles in shivering leads to heat production. The shivering attack, or rigor, is a method the body has, so to speak, of getting up steam. When the disease has run its course, the temperature falls; either gradually, by 'lysis,' or suddenly, by 'crisis': this latter occurring typically in pneumonia. The sudden fall of temperature in crisis is accompanied by profuse sweating. Once a man was born who was normal in all respects but one; he had no sweat glands and so could not perspire. He could not work in the summer because the muscular exertion sent up his temperature too high; the only way he could keep going was to soak his shirt in water. This is an actual fact, and shows how the interaction of muscular exertion and sweating helps in the regulation of body temperature.

Methods of Dealing with Germs

In 1867 the English surgeon, Joseph Lister, published a paper entitled *On the Antiseptic Principle in the Practice of Surgery.* For a long time Lister, with most of his contemporaries, had been gravely perturbed by the 'septic' complications of operations. Although a most careful

operator, 42% of his amputation cases were fatal. By chance he became acquainted with the work that Pasteur was doing in France, and he set about trying to prevent the development of germs in wounds. Lister realized that Pasteur's method of heat sterilization could not be applied to wounds, so he searched for a chemical antiseptic. He experimented with zinc chloride and with the sulphites, and finally hit upon carbolic acid, which he painted, at first, directly on the wound. Later he sprayed his operating theatres with carbolic acid, and also incorporated it in the dressings he put on wounds. Lister's antiseptic surgery prepared the way for the modern aseptic surgery, in which the surgeons and nurses wear sterilized gowns, masks, and gloves; the patient is covered with a sterilized sheet with an opening over the place on which the surgeon is to operate; the knives, forceps, and towels are sterilized, and the patient's skin is painted with an antiseptic such as iodine. In this way all the germs are killed before the operation begins. Lister was indeed the founder of modern surgery.

Since the early work of Pasteur, Lister, and Koch (who proved the value of mercuric chloride for destroying the spores of bacteria) the principle of disinfection—the killing of germs—has been thoroughly worked out. Germs can be killed by heat, by sunlight, by such chemicals as potassium permanganate, mercuric chloride, iodine, spirit, chlorine, phenol and cresol, and they can be excluded from water by filtration. By methods based on this knowledge our water supply has been made safe for drinking purposes, and the incidence of such diseases as cholera and typhoid enormously cut down. A question of disinfection that has long been before the public eye—and should weigh more heavily upon the public conscience than it appears to do—is that of safe milk. Approximately two thousand children die every year from infection by the bovine tubercle bacillus, and four thousand fresh cases are infected annually. Children are infected by this germ through contaminated milk. Pasteurization (that is, a special method of heating) of milk would greatly diminish this appalling death roll, yet the opposition of individual farmers is allowed to prevent the taking of a measure so essential for the public safety. In the meanwhile the wise mother will see that her child does not receive milk which has not been either pasteurized or boiled.

Germs not only infect milk and water, but they also contaminate food, and outbreaks of food-poisoning are frequently traced to contaminated food sold in a shop or a restaurant; as was the pease-pudding outbreak in the St. Pancras area of London in 1933, which was due to a particular germ. The large catering firms keep a very strict control over their food, and have it continually tested for the presence of germs, for the protection both of their customers and themselves.

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In most districts it is now compulsory for such infectious diseases as

measles, scarlet fever, and diphtheria to be notified; patients suffering from these illnesses being usually treated in special fever hospitals, so that by the segregation of the infected the disease can be brought under control. Another way to limit these infections is by the inoculation or vaccination of the community against them. The most famous example of this limitation is smallpox, which is now, largely thanks to vaccination, an uncommon disease. The man who introduced vaccination against smallpox was a physician called Jenner, who was born in the eighteenth century. Jenner noticed that dairymaids who, through milking cows, contracted the mild malady called cowpox never succumbed to smallpox. From this fact he conceived the simple but brilliant idea of protecting people from the dreaded scourge of smallpox by giving them the milder and inoffensive disease of cowpox—and this is the method that has been practised ever since. Attempts have, of course, been made to protect populations against other infections, and remarkable success has been achieved in America in immunizing children against diphtheria by the injection of small quantities of diphtheria toxin and anti-toxin. The incidence of diphtheria and the mortality from it has been considerably reduced in the United States of America as a result of this practice.

Measures of protection against infection in any community are greatly helped by finding out which of its members are susceptible to a given disease. Three diseases with regard to which a test for susceptibility is frequently carried out are tuberculosis, scarlet fever, and diphtheria. If a very small quantity of the toxin from the diphtheria bacillus is injected under the skin of a person susceptible to diphtheria a raised red patch, less than an inch in diameter, will appear at the site of injection within one to two days. If the patient is immune—that is to say, if he already has anti-toxins to this disease in his blood—this red patch will not appear. The same kind of test is carried out with scarlet fever and with tuberculosis. This method of finding out which individuals are liable to catch diphtheria or scarlet fever is of particular value in schools and in fever hospitals, as the susceptible children and members of hospital staffs can be immunized against the infections in question. These two tests are called after the names of the scientists who instituted them—the Schick test and the Dick test, respectively.

Some of the most successful results in the prevention of disease by means of vaccines have been obtained in typhoid fever. As has been explained earlier the injection into a human being of killed bacteria induces in the blood the formation of anti-bodies to those same bacteria. Thus, when a person so vaccinated is exposed to actual infection with the live bacteria he will be already armed with anti-bodies to deal with them. It has been said that if it had not been for vaccination against

typhoid the last war would have come to an end very much sooner than it did. As it was, inoculation of the fighting forces against typhoid, on a vast scale, protected them from the attacks of this disease and preserved them for the far more horrible ravages of war. On a much lower plane we may note the brilliant results obtained in protecting dogs against distemper. Dogs can now be inoculated against this once devastating disease with nearly a 100% guarantee of success. The reader may get some idea of the arduous and prolonged character of scientific research when he is told that this work on dog-distemper took ten years to complete, and cost £50,000. Incidentally, the investigations led to the discovery of the cause of influenza. In time, we may hope, the cure of this international malady may also be discovered.

Acute Infective Fevers

Up to this point we have been chiefly concerned with the general characteristics of bacteria—what they are, how they live, what effects follow upon their invasion of the body, how the body resists them, and what are the general methods that we employ when combating these microscopic but powerful organisms; sometimes enemies of society, sometimes bringers of good gifts. The next paragraphs will be devoted to a more detailed description of some of the commoner infections, and in this it is not intended to follow a strictly logical order according to the types of bacteria that cause these infections, but to group them in a way that can be easily followed by the reader. We begin with the common fevers—diphtheria, measles, scarlet fever, whooping-cough, mumps, and chickenpox.

These fevers are characterized by a sudden onset of illness, with raised temperature and certain symptoms and signs the grouping of which differentiates one fever from another. Each fever runs a typical course, which may or may not be interrupted or prolonged by complications peculiar to itself. Thus scarlet fever starts suddenly with headache, sore throat, and vomiting; a rash appears within the first twenty-four hours of the disease; the temperature is usually normal by the sixth day; whilst inflammation of the kidneys and of the ears is a common complication. These features distinguish scarlet fever from other infections, and enable physicians to identify and classify it as 'a disease' by itself. Later in the field come the bacteriologists, who find that this 'disease by itself,' or specific infection, is caused by a 'germ by itself,' or specific microbe. The diagnosis of a typical case of scarlet fever, for example, does not present any difficulty to the experienced doctor; but in mild cases and in cases which are first seen in a late stage of the disease diagnosis is often by no means easy. For

instance, a child with an ordinary sore throat may have a rash resembling very closely that of scarlet fever. Overdoses of certain drugs, mild food poisoning, or the giving of an enema may also set up a scarlet-fever-like rash, and a similar rash may appear in measles, smallpox, and chickenpox. So in examining a child with a rash like that found in scarlet fever the doctor has to bear in mind the various conditions that can be associated with such a rash. The character of the rash, the parts of the body covered by it, the presence of some signs and the absence of others, the story the patient tells, etc., all help him to make up his mind. But, even so, diagnosis is not always easy.

SCARLET FEVER.

We have already mentioned some of the characteristic features of scarlet fever. It is common in Europe, being especially prevalent in England in the autumn months. Mainly a disease of children, it can also attack adults. It is caused by infection with a small spherical germ, called the streptococcus of scarlet fever.

When a germ invades the body the patient does not necessarily become ill at once. There is a period called by doctors the incubation period which varies in duration with different fevers—between the actual infection with the germ and the first manifestations of illness. That is why children who have been exposed to infection are put into quarantine (that is, separated from others for a certain time). If the period of incubation is, say, three days, and a child is exposed to infection early on a Monday, it will not be known until late on the Wednesday whether he or she has caught the fever. A safe quarantine period for scarlet fever is usually considered to be ten days. The infective agent of scarlet fever is undoubtedly present in the secretions of the throat and the nose, and it is easy to see how infection can be spread by towels, handkerchiefs, feeding utensils, clothes, bedding, etc. The necessity for disinfecting such articles is obvious. Sometimes milk has become contaminated, and widespread epidemics have broken out as the result of such contamination.

The child with scarlet fever usually has brightly flushed cheeks with definite pallor round the mouth. The vivid scarlet rash appears first on the sides of the neck and the upper part of the chest, and then extends downwards over the whole of the body. It consists of minute, brilliantly red points set very close together. By the end of the first week the rash has usually faded, coincidently with a fall in temperature. Other distinctive symptoms have been mentioned above. With the fading of the rash the skin begins to peel, sometimes coming off in long flakes, sometimes as a light powder. This peeling continues from the end of the first week for another four or five weeks. It used to be thought that the peeled-off skin was infective, but this view is no longer

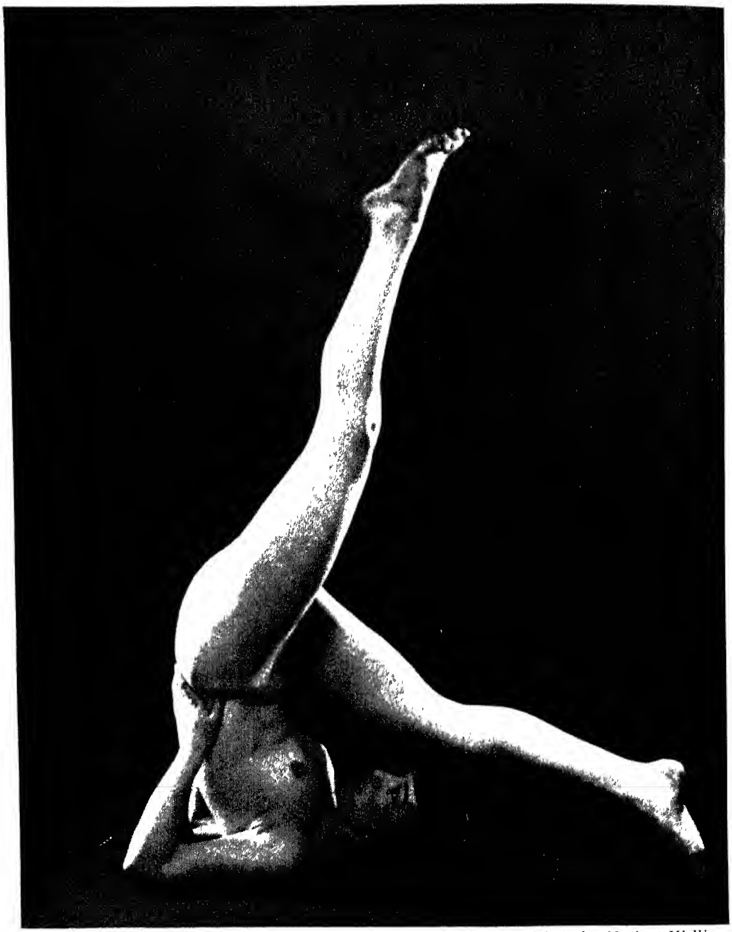


Photo by Herbert Williams

GYMNASTIC POSE—TRIPOD SUPPORT—ELBOWS AND HEAD

DIAGRAM OF SUPPORT

A, B, C, feet of supporting tripod

held, and children are often allowed to go home from hospital after four weeks have elapsed. If, however, a child has a 'running nose,' it is detained in hospital so long as the nose runs, for it is by such discharges that infection can still be spread, although the child may feel and appear quite 'well.'

Scarlet fever is, fortunately, not the serious disease it used to be; but such complications as infected glands in the neck, which may have to be lanced, inflammation of the ear, and of the kidneys, may occur and have to be specially treated. Bad cases of scarlet fever are often now injected with an anti-scarlatinal serum, which is undoubtedly beneficial. The essential treatment is the keeping of the patient in bed while isolating him from other children. As three weeks is the average period for this, it can be done most conveniently and efficiently in a special fever hospital. Care must be taken during convalescence from scarlet fever as at this stage patients are especially liable to contract diphtheria. There is now a special test (the Dick test) for finding out what children are susceptible to scarlet fever, and those who are susceptible can be inoculated against the disease.

MEASLES.

There seems little doubt that measles is caused by a specific microbe, but as yet this microbe has not been identified. Measles is a serious disease, being especially common during the first five years of life and in the winter months. A second attack in the same individual is exceedingly rare, so that a high degree of immunity must result from the illness. It is a highly infective malady and is usually transmitted directly from person to person, by the infective material present in the discharge from the nose and throat. One sneeze may do a lot to spread an epidemic. The incubation period is about a fortnight, and the quarantine period fifteen days. The most infectious period is in the early stages of the disease, during which the diagnosis may, unfortunately, still be in doubt, as the rash typical of measles does not appear until the foruth day of the disease. There, are of course, certain signs which may help the doctor to make an early diagnosis—such as the little white points that can be seen in the inside of the mouth—but it is not infrequently a matter of some difficulty.

Measles starts with an acute catarrh of the eyes, nose, and throat; bronchitis, and a fairly high temperature. The child usually feels ill and miserable, and does all it can to shield its eyes from the light: it 'runs' at the eyes and the nose. In a measles epidemic any child that seems to have a severe cold in the head should be seen by the doctor. The rash, which appears on the fourth day of the illness below the ears and about the roots of the hair on the brow, afterwards spreading over the face and then over the rest of the body, consists of raised spots

ranging in colour from dusky red to pink. These spots are grouped together in clumps, giving the skin a blotchy appearance. After about two days the rash begins to fade. Within a week, unless there are complications, the temperature is normal.

It is the likelihood of certain complications that makes measles a grave disease, and of these the most serious is broncho-pneumonia, which not only is difficult to treat, but sometimes permanently damages the lung. Laryngitis, inflammation of the ear, and various nervous troubles may also follow. A child with measles is best treated in a fever hospital, where he will get skilled nursing and constant medical attention. Measles is now often successfully treated with serum obtained from patients who have had and recovered from the illness. This serum can be given to the healthy as a preventive measure in an epidemic, or to the infected in the early stages of the disease. The amount of serum available in a normal community is, of course, limited, but its employment is certainly of great use.

GERMAN MEASLES.

German measles and measles are distinct diseases. 'German' is not a continental variety of 'English' measles. It is a mild malady, common in the spring and early summer. The germ that causes it has not been discovered, but the infective agent is apparently present in the catarrhal discharges of the nose and the throat. The incubation period is long —somewhere between a fortnight and three weeks—and children who have come into contact with the fever should be in quarantine for the longer period. Patients in whom the disease has appeared should be isolated for ten days. German measles starts with a cold in the head, with running at the eyes and the nose, and a rise of temperature. In a typical case there is definite enlargement of the glands in the neck. The rash of rose-pink separate spots may be the first thing to be noticed, and does not usually appear later than the second day of the disease. It appears first on the brow and behind the ears, and then spreads over the body.

Severe complications are very rare, as are second attacks. The temperature is normal within a week, and during this time the patient should be kept in bed on a light diet. Otherwise no special treatment is needed.

SMALLPOX.

It is an interesting and curious comment on our boasted civilization that, with the means of absolutely preventing smallpox at our disposal, we allow the prejudices of a small minority still to expose the country to not infrequent outbreaks of a peculiarly repulsive and filthy disease. But unfortunately, so long as vaccination and revaccination cannot be universally

enforced, smallpox will continue to be with us and, unfortunately also, will continue to be the cause of most regrettable loss of life and waste of money.

The above is a quotation from a well-known textbook on infectious diseases. It seems that at present the number of unvaccinated people in England is increasing yearly. To-day the type of smallpox prevalent is mild: if a severe form of the disease broke out the consequences would fall most heavily on the unvaccinated. Since the introduction of vaccination there has been a marked fall in the incidence of and mortality from smallpox; and most doctors—though not all—believe that the disease could be stamped out completely if the whole population was vaccinated. General medical opinion is that infants should be vaccinated in the first six months of life; and that revaccination should be carried out at the ages of five to seven years when the child goes to school, and again when he leaves school, between fourteen and sixteen. If infants are vaccinated during the first three months of life and with the methods at present in use, the rare nervous complications that have been reported do not now occur.

The germ which causes smallpox has not yet been discovered, but it is probable that it is a filter-passing virus. The incubation period is from ten to fourteen days, and the quarantine period sixteen days. A patient with the disease is usually isolated in a special hospital for from six to ten weeks. Smallpox attacks people of all ages, and is a disease chiefly of winter and spring. It spreads by direct infection from person to person; possibly, also, by the air. Clothes and bedding are infectious and need disinfection, as does the house in which the patient has lived.

The disease starts suddenly with headache and shivering as prominent symptoms, and a high temperature. The rash appears on the third day of the illness. To begin with it consists of dull red spots, which soon become raised above the skin, on the brow, and on the wrists. Later these raised spots become filled with a clear fluid, which by the eighth day turns into pus or 'matter.' Later these 'pocks' burst, a scab forms and separates, and a scar is often left behind. The temperature is normal by about the sixteenth day. Laryngitis, bronchitis, pneumonia, and ear disease are among the complications of smallpox. In an epidemic it is most important to call in a doctor, even if the suspect has only three or four raised spots on the skin and does not appear to feel ill.

CHICKENPOX.

Chickenpox in many respects resembles smallpox, and is usually only distinguishable from it by a doctor; though it has no apparent connection with the latter disease. It is probably caused by a filter-

passing virus. Relatively a mild disease, it is most prevalent during the autumn months, and commonly attacks children during the first ten years of life. It spreads by direct contact from case to case; possibly, also, infection can be conveyed by air. The incubation period is from two to three weeks, and the quarantine period is three weeks.

The rash is usually the first symptom to be noticed. This appears as a raised spot which soon forms a circular or oval blister or vesicle containing clear fluid, which fluid later becomes cloudy or purulent, that is, containing pus. The spots are found on the chest and the back, the face, and the scalp, in the mouth, and to a less extent on the limbs. The fluid in the spots either dries up or escapes on to the skin. A scab forms and finally separates. The rash is often very irritating, and the patient has to be discouraged from scratching, otherwise scarring may result. The fever is not usually high, and subsides within a week.

There seems to be a close connection between chickenpox and shingles. Children with chickenpox should be quickly isolated from others, and kept in bed until the temperature is normal, and away from other children until all scabs have separated. Second attacks are extremely rare.

MUMPS.

The infectious diseases we have so far discussed are characterized by rashes of various kinds. Mumps, which is a disease caused by a filter-passing virus, is an infection of the gland called the parotid, situated behind the angle of the jaw. It is one of the glands which secrete saliva. Mumps is a disease of the spring and the autumn, and is common among children between five and fifteen years of age; though adults are occasionally attacked. The incubation period is from twelve to twenty-six days, and the quarantine period is twenty-six days. Infected children are usually isolated for three weeks.

It often starts with headache, chilliness, and nose-bleeding, and the first noticeable symptom is a swelling on one side of the neck between the angle of the jaw and the ear; the gland on the other side usually swells a day or two later. The swelling is very tender, and eating and laughing and even opening the mouth become painful matters. The appearance of the patient is slightly grotesque and rarely evokes sympathy. Within a week to ten days the swelling subsides, but the patient should be kept in bed for the full ten days. As the virus is short-lived, disinfection of clothes and so on is not really necessary. Second attacks are very rare.

It is important for the patient to be kept in bed in order to avoid the risk of complications. Ear disease and deafness, inflammation of the pancreas, and swelling of the testicles are not common, but when they occur are serious sequels to mumps.

WHOOPING-COUGH.

This troublesome complaint is common amongst infants and young children between January and April. It is caused by a bacillus and is highly infectious, spreading directly from patient to patient and by the clothes. The incubation period is from a few days to a fortnight, and the quarantine period is twenty-one days.

Whooping-cough starts as a bad cold, the patient sneezing and running at the eyes, becoming listless, and going off his food. Soon the cough comes on in spasms and the child is often sick; and, finally, the typical whoop appears. The patient has a succession of coughs as if he were trying to get rid of something; during this coughing bout he does not breathe in, and the bout is ended by a long drawing in of air which produces the crowing noise we call a whoop. After the whoop the child is often sick. During the paroxysm the face and the eyes are congested and swollen; there may even be a haemorrhage into the eyelids and the whites of the eyes. These paroxysms are very exhausting, and the unfortunate invalid, with his pale, puffy, weary-looking face, is a picture of misery.

Amongst other complications bronchitis, pneumonia, and convulsions are the most serious. The average period of isolation is six weeks.

Whooping-cough is a serious disease and must be kept under careful medical supervision. Children in a poor state of health may later on develop tuberculosis unless every effort is made to build up their health during their convalescence. Some success has been obtained in vaccinating against whooping-cough, but this is not practised on a large scale in England.

DIPHTHERIA.

The treatment of this illness has largely fulfilled the expectations of the discoverers of the disease-producing germs. Taken in its early stages it responds dramatically to injections of anti-toxic serum, and preventive inoculation is remarkably successful in protecting children against infection. A special skin test (the Schick test) enables the doctor to find out what children are susceptible to the disease. In America the incidence of diphtheria has been considerably reduced as the result of a widespread and thorough-going compaign of inoculation. In England we still lag far behind in this respect, but there seems little doubt that if the pre-school and school-age population could be vaccinated against diphtheria it would become a rare disease, and an avoidable mortality would disappear.

Diphtheria is common among children between one and ten years old in the winter months. It spreads by direct contact—for example, by kissing—by infected pens and pencils in schools, by infected clothes

and towels, and sometimes by milk. We have previously mentioned the spreading of this disease by healthy carriers. The domestic cat has also been blamed, but, it is thought, unjustly. The bacillus that causes diphtheria may attack the throat, the nose, or the larynx. The incubation period is from one to three days, and the quarantine period twelve days. The quarantine period is not here relevant, for the doctor usually makes a bacteriological examination of the throats of suspects or contact cases, as discovery of the bacillus under the microscope is the surest way of diagnosing the disease.

At the onset of the illness the child feels ill, with perhaps a headache and vague pains. The throat feels sore and there is fever. A white patch appears on one or both tonsils and soon spreads. At the first sign of a sore throat in a child the parent should immediately send for a doctor, for any sore throat may turn out to be diphtheritic, or, on the other hand, may be the beginning of scarlet fever. The important thing to remember is that the sooner the child with diphtheria can be given anti-diphtheria serum the better will be its chances of recovery. The whole idea of the treatment is to stop the disease before the toxins of the diphtheria bacillus can establish themselves in the tissues of the body and do serious damage. In a suspected case a doctor will usually inject serum or send the child into a fever hospital before it has actually been proved that the patient is suffering from the disease. This is a wise measure and should not be resisted by those responsible for the child. As a result of serum treatment the case death rate from diphtheria has decreased considerably; but diphtheria remains still a prevalent and serious illness. Patients who have had serum injected frequently develop a rash and complain of pains in the joints (serum sickness), but this is no cause for alarm. Very occasionally, severe shock immediately follows the injection of serum, but this can nearly always be controlled by the injection of a drug called adrenalin.

Second attacks of diphtheria are not uncommon, and the doctor should always be informed if a child has ever had a previous injection of serum. It is a curious but explicable physiological fact that the shock just mentioned usually occurs when second injections of serum are given after a certain interval of time has elapsed.

The toxins produced by the bacillus affect the kidneys; and may attack the nerves and cause paralysis of the eyes, of the palate, and of other parts of the body: whilst they may also bring about a serious failure of the heart and circulatory system.

A very grave complication occurs when diphtheria spreads to the larynx and the child develops a croupy cough. The larynx may become blocked up and the child be unable to breathe. In this serious emergency the doctor may have to perform an immediate operation by making a hole in the windpipe just below the larynx (the Adam's

apple), and inserting into the hole thus made a metal tube through which the patient can, temporarily, breathe.

ENTERIC FEVER.

Enteric fever is a name given for convenience to a group of allied diseases caused by similar organisms, the typhoid, and the three paratyphoid, bacilli known as A, B, and C. Of these, typhoid fever is the most serious and will here be the only one considered; for much of what is said about typhoid applies also to the paratyphoid fevers. Typhoid occurs in all parts of the world, is most prevalent in autumn, and is commonest between the ages of ten and twenty-five. The infection is conveyed by water and milk, by food (e.g. watercress, ice cream, and shell-fish), by contaminated bed-linen, and by 'carriers.'

The typhoid bacillus attacks the small intestine, and the bacilli pass out in the faeces of the patient. Therefore, if the drainage is defective, neighbouring water supplies may easily become contaminated, as in a well-known outbreak at Malton in Yorkshire. The organism is killed if submitted to the temperature of boiling water for three minutes. Owing to our vastly improved methods of sanitation, typhoid is now an uncommon disease in England. When, as in the army in war-time, people are crowded together and the sanitation is bad, protection can be secured by inoculation against the typhoid and paratyphoid fevers. The disease can be diagnosed at the end of the first week by a special laboratory test—the Widal test. The incubation period is between one and three weeks.

Typhoid fever starts with a general feeling of illness, headache, pains in the back and limbs, insomnia, loss of appetite, bronchitis, pain in the abdomen, occasional vomiting, and either constipation or diarrhoea. There is also a heightened temperature, which gradually rises during the first week. During this period diagnosis is often difficult, as there is nothing pointing very clearly to any specific infection. Towards the end of the first week the spleen may be felt to be enlarged, rose-pink spots appear on the abdomen, the bacillus can be found in the faeces, and the Widal test is 'positive.' The fever may continue for another two weeks, and even longer. Relapses are common. During the second and third week the patient, in bad cases, often becomes deaf, delirious, stupid, and extremely weak. He also suffers from a troublesome diarrhoea. At this time haemorrhage or perforation of the bowel may occur, since ulcers form in the intestine as a result of the infection. Pneumonia and clotting of blood in one of the veins in the groin are other common complications.

A patient with typhoid is best treated in a special fever hospital. It is a serious disease, and calls for the greatest skill in nursing: many a typhoid patient owes his life to the attention of an experienced nurse.

TYPHUS FEVER.

Typhus or jail fever is now practically unknown in England, but is prevalent in Russia and the Balkans. It is a louse-borne disease, and disappears with the spread of public hygiene and personal cleanliness. It was once very prevalent, and in jails notoriously endemic; on one occasion, still remembered as the 'Black Assizes,' infection from the prisoners on trial carried off judges, counsel, and court officers.

CEREBRO-SPINAL FEVER.

This is also known as spotted fever. It is an inflammation of the covering skins or membranes (meninges) of the brain and spinal cord due to invasion by a germ called the meningo-coccus. It is not uncommon in children under fifteen, and is especially frequent in infants. From time to time there are outbreaks of the disease in the army as conditions of close personal contact and overcrowding favour the spread of the disease. The germ lurks in the throat, and is conveyed from one person to another by coughing, sneezing, or kissing, or drinking from infected vessels. Healthy people may carry the germ in their throats and infect others. The incubation period is probably from one to five days.

Attacking as it does such an important structure as the covering of the brain and the spinal cord, cerebro-spinal fever is a grave disease. It starts very suddenly with a severe headache, vomiting, and stiffness of the neck. Shivering attacks, or in children convulsions, are also common. The temperature rises, and the patient become delirious and often violent. Small haemorrhages appear under the skin, whence the name spotted fever. If recovery takes place the unfortunate patient may be permanently disabled with paralysis, deafness, or other disabilities, some of them psychic.

The outlook in this disease has considerably improved since the introduction of two important measures of treatment. As we know, the brain and the spinal cord are surrounded and protected by a bag of fluid called the cerebro-spinal fluid. This fluid can be tapped if the tip of a hollow needle is pushed into the sac containing it, and two convenient places for this operation are just below the base of the skull at the back of the neck and at the lower end of the spinal column. The needle is inserted between adjacent vertebrae. In spotted fever the cerebro-spinal fluid becomes very thick, as a result of the infection; more fluid than normal is also secreted, and this gives rise to an increase of pressure on the brain and spinal cord. If the doctor drains off this excess fluid he relieves the pressure, and also removes some of the infected matter. The other measure is the injection of an anti-meningococcus serum into the cerebro-spinal fluid and into the blood-stream,

either under the skin, or into the muscles of the patient. These two methods of treatment have together much reduced the mortality of spotted fever.

ERYSIPELAS.

Erysipelas is an inflammation of the skin caused by a germ called the streptococcus. There are many varieties of streptococcus; erysipelas is probably due to infection with one particular variety. It is common in the winter months in persons between the ages of twenty and sixty, and spreads by direct contact and by infected clothes. The incubation period is three to eight days.

Erysipelas starts suddenly with a shivering attack, and a rapid rise of temperature. The patient complains of headache and is sick. The characteristic inflammation often begins at the inner angle of the eye or in the neighbourhood of a nostril. A patch of redness appears and spreads over the face; the affected skin being deep red, swollen, tense, shiny, hot, and raised above the surface of the surrounding parts. As the raised, spreading edge advances the older inner part begins to fade in intensity. The redness is fairly vivid for from four to five days. The patient feels a burning, smarting sensation; the eyelids become extremely swollen; sleeplessness and delirium are common. Erysipelas may wander about all over the body. Relapses and second attacks are not uncommon, and possible complications include pneumonia and nephritis.

The most successful form of treatment is the injection of an anti-erysipelas serum. A thousand-and-one local remedies have been tried, but none is really successful.

Some Other Infections

VENEREAL DISEASES.

In his book, *Devils, Drugs, and Doctors*, Dr. Howard writes: 'The venereal diseases are involved in that great sex problem about which the ideals and ethics of Christian civilization centre. . . . A true perspective on sexual matters is lost because the facts are obscured with secrecy and distorted in the imagination.' Gonorrhoea and syphilis are the two venereal diseases which have caused an appalling waste of human happiness, health, and money. These infections attack the genital organs of men and women. The infection spreads from one person to another as a direct result of sexual intercourse with an infected person. In very rare cases infection may be conveyed by contaminated towels or clothes, or from lavatory seats. Man and wife, neither of whom have or have had sexual relations outside marriage, do not

contract the disease, which depends for its continuance upon promiscuous sexual relationships.

Gonorrhoea is the result of an infection with a germ called the gonococcus. It is an acute inflammation of the sexual organs of the male and the female, and is characterized by a discharge from these organs. It is extremely difficult to treat successfully unless taken in the early stages, and any one infected or who suspects an infection should immediately seek advice from his or her doctor or, if certain of the nature of the trouble, at the nearest venereal disease clinic. The complications of gonorrhoea are troublesome and serious, and may result in years of misery and grave ill-health. It is perhaps unnecessary to say that any one with gonorrhoea should not have sexual intercourse until he or she has been properly treated, nor should any one who has had it marry until he or she has been carefully tested by an experienced doctor to make sure that the risk of infecting another person no longer exists.

Syphilis is due to infection with a thin, spiral-shaped microbe called a spirochaete. The disease first shows itself as a round, hard sore, about the size of a threepenny bit, on the external genital organs of the male or the female. About three or four weeks after the sore has developed, a rash appears on the body and simultaneously with, or following, this certain other symptoms such as a sore throat with ulcers in the mouth, and painful joints, may develop. Later on syphilis may — and, if untreated, certainly will—attack various parts of the body—the bones, the liver, the lungs, and so on. When it attacks the heart, which may occur some two to five years after the initial infection, the condition is very serious. But the gravest complications arise when the brain or spinal cord become infected, and this may happen as long as twenty years after the date of the original attack of the disease. General paralysis of the insane and locomotor ataxy are two of the most tragic results of syphilitic infection of the nervous system. It is largely on account of its after-effects that syphilis is of such grave consequence, no part of the body being immune against it. It is because of this, and of the tragic possibilities for others, that it is so essential for any one infected with syphilis to seek a doctor's advice at the earliest possible moment, and to submit patiently to the necessary course of treatment, however long it may be. Syphilis is one of the heritable taints; whilst if a woman has syphilis and becomes pregnant, her child, if born alive, will also be directly infected.

TETANUS AND ANTHRAX.

Tetanus, or lockjaw, is a disease caused by a long, rod-shaped bacillus. The tetanus bacillus is found in the soil in highly-manured fields and gardens, and in the faeces of various animals. Like diphtheria, it

produces its ill-effects by means of the toxins it excretes; and, like diphtheria, tetanus is now treated by an anti-toxic serum, though the results are not so universally good. The germ usually gains entry to the body through some cut or injury, and the disease begins as a slight stiffness of the jaw muscles, developing into a spasm which prevents the patient from opening his mouth. The spasm spreads to the muscles of the face, of the trunk, and of the limbs. Sudden intensification of the spasm takes place from time to time, causing the patient excruciating pain.

This grave disease is fortunately not common, though its mortality is high. Treatment with serum at the earliest possible opportunity gives the doctor his best chance of saving his patient. As a preventive measure, injections of anti-toxic serum are given to patients with wounds contaminated with road sweepings or garden soil. This treatment was used extensively in the Great War, in which soil-infected wounds were very common, and saved countless lives. Any serious wounds which are contaminated with garden soil or refuse should immediately be shown to a doctor, who may think it wise to inject anti-tetanus serum —tetanus being always a possible result of such wounds.

Anthrax, also known as woolsorter's disease, is a disease primarily found in sheep and cattle, and conveyed to man by the handling of hides, wool, and carcasses of infected animals. The germ which causes anthrax is a long rod-shaped bacillus. Anthrax begins suddenly and violently, the patient being almost at once acutely ill. The outward sign of the disease is a large spot, which looks very like a boil, on the face or the arms, or at the back between the shoulders. The bacillus may invade the lungs as a result of inhaling dust from infected hair or wool.

The disease is grave, but fortunately uncommon, and is now treated by anti-anthrax serum.

SLEEPY SICKNESS AND INFANTILE PARALYSIS.

Infantile paralysis is an acute disease of the nervous system caused by a filter-passing virus. This virus attacks those nerve-cells in the brain and the spinal cord which control muscular movement; and the characteristic feature of the disease is a wasting and paralysis of the muscles. It is a not uncommon malady during childhood and early adult life.

It begins as an acute illness, with fever, headache, and pains in the limbs, and soon paralysis of an arm or leg manifests itself. After the subsidence of the acute symptoms, some degree of paralysis always remains, but massage and exercises during convalescence do much to remedy matters; sometimes slight surgical operations are helpful. Where growth is completed at the time of the attack, the paralysis is

often the only sequel; but in children the wasting of the affected limb or limbs disturbs the muscular balance, and deformities and distortions of all kinds may develop as the child grows. Recently, attempts have been made to treat the disease with serum, but the evidence as to its value is conflicting.

Sleepy sickness also is an acute disease of the nervous system, and it too is caused by a filter-passing virus. This disease is now comparatively rare. Attacking the base of the brain, its gravest feature is its serious after-effects. After the patient has apparently recovered, he sometimes develops a slow form of paralysis, or manifests mental and moral changes that may necessitate permanent segregation from the community.

INFLUENZA AND THE COMMON COLD.

Influenza is the commonest of the great epidemic scourges from which we still suffer. As yet we are far from knowing how ultimately we may lessen its incidence or increase our prospects of recovery from it. A detailed description of its varying symptoms is unnecessary; for, unfortunately, nearly every one in this country is familiar with them either at first or second hand. The manifestations of influenza vary a good deal in different epidemics; sometimes the stomach and digestive apparatus are notably disturbed; sometimes the lungs and other respiratory organs are specially attacked; whilst in yet other epidemic invasions, the nervous system stands out as the chief victim. We do not yet know with certainty by what means the virus of influenza spreads. Direct contagion is almost surely one of them; but it can hardly account for the rapidity with which influenza often travels from one country to another—often in almost opposite quarters of the globe—the pace being frequently far greater than that of any contemporary method of human transit. Nor has it been found possible to define with any approach even to probability, what are the atmospheric conditions, humidity, temperature, and so on, common to the several countries coincidently attacked—conditions which might with some plausibility be held to predispose. It has, however, been proved beyond reasonable doubt that the specific provocative agent is an ultra-microscopic virus, the virulence of which presumably varies from time to time according to a number of as yet undetermined circumstances. We know how different in severity and in fatality are successive epidemics of influenza. In England and Wales the mortality rate from the epidemic of 1918–19 in the course of forty-six weeks was 4,774 per million of the population —more than half as big again as that of the great cholera epidemic of 1849.

It is impossible to give any useful advice as to precautionary measures that may be taken against this disease, beyond recommending that

everything be done to keep the body's resilience and reactive power at their highest level of efficiency. When influenza is about, any one who is made aware by a shivering fit, a sore throat, a headache of unusual severity, or a sudden development of *malaise*, that he is likely to have caught the disease, will be wise to go straight to bed, and to remain there until he feels himself again. If his symptoms increase in severity, he should send for a doctor without undue delay.

The common cold is, compared with influenza, of pathologically inferior status. It shares with that disease the distinction of having for centuries baffled, and of continuing to baffle, the persistent efforts of medical science to prevent or master it. It is as widespread to-day as ever it was; and it cannot honestly be said that we are in any better position to resist or overcome it than were our grandfathers. Like influenza, the common cold seems to effect its entry into our bodies through the respiratory passages. If, however, its manifestations and consequences were limited to that symptom, nasal catarrh, which is peculiarly associated with it, there would be small need for concern. Unfortunately, a cold does not always confine its attack to the nostrils, or even to the throat. It is often the starting-point of grave and seemingly remote disorders, and it should never be treated too lightly. The common cold, like influenza, has been proved to be conveyable by means of a filter-passing virus—that is, an entity capable of self-multiplication, so much smaller than any known germ that it will pass through the pores of a fine filter. People who lead active, outdoor lives, feed themselves simply yet well, clothe themselves sensibly but not excessively, and sleep in cool, airy conditions, are found, on the whole, to be those least liable to 'catch cold,' and most successful in overcoming the infection when attacked.

RHEUMATIC FEVER.

Rheumatic fever, or acute rheumatism, has little connection with most of those chronic disorders that are commonly classed as rheumatic. It is, evidently, a germ-caused disorder, in which there is a considerable idiosyncratic element. Popularly, acute rheumatism has been assumed to be related to chronic rheumatic diseases, because it is usually, or often, characterized by a painful swelling of joints. This, however, is by no means a necessary or universal symptom of the disease. Tonsillitis, so-called 'growing pains,' and, as some hold, chorea or St. Vitus's dance, may each be a manifestation of the invasion of the body by the streptococcus now generally assumed to be the specific organism concerned in rheumatic fever. The form in which the disease commonly presented itself thirty or forty years ago, seems now to be much more rarely seen; but the outstanding consequence of an acute rheumatic attack—namely, endocarditis and valvular disease of the heart—

is as much in evidence as it used to be. Prolonged rest in bed is perhaps the most important part of the treatment of an acute rheumatic attack. The management of such a case is always a matter for an experienced doctor. The drug on which physicians most rely is salicylate of soda; but, in dealing with a disorder with such grave possibilities, amateur doctoring is out of place. Whenever a child, or young person, complains of a sore throat, of pains in the muscles or joints, or of swelling in these latter, careful observation should at once be made; and if the symptoms do not disappear within a few days at most, a doctor should be consulted.

The fact that acute tonsillitis is so commonly associated with juvenile rheumatism suggests that infection is usually by way of the throat. It is much commoner among poor children than among those of the well-to-do classes. It can hardly be that poor children encounter germs which studiously avoid rich children; though, of course, the crowded conditions of their homes may subject the former to more heavily germ-laden atmospheres. Again, it is not likely that well-to-do children constitute an innately immune strain; for our class barriers are no longer high enough to prevent constant crossing. We are left with the presumption that there is in the early environment of a large number of working-class children, something distinguishing it from that which almost universally obtains in better-to-do circles, which exposes these children to greater risks or makes them more pathologically susceptible. This would seem to limit the range of potential causative factors to food, clothing, domestic atmosphere, and degree of sunlight. Damp and overcrowding are conditions specially suspect; and they both appear to favour the disease; but deficiencies in diet are perhaps the chief among predisposing causes.

VI—THE ENDOCRINE SYSTEM AND METABOLIC DISORDERS

THE word gland is familiar to everybody, but it is difficult to define exactly what is understood by this term. For our purpose it is sufficient to divide glands into three classes: lymph glands, glands with ducts, and glands without ducts.

LYMPH GLANDS

Lymph glands are rounded bodies set at various points along the course of the network of lymphatics. They consist of masses of small cells called lymphocytes, and their function seems to be to supply these to the blood and to act as obstructions to the spread of an infection. Lymph glands belong to the system of lymphoid tissue, which is widely distributed in the body. Of this the tonsils are well-known examples, and they constitute a barrier against infection entering the system by the throat. Should the tonsils become weakened and infected they may themselves become a source of danger.

It is common knowledge that if a cut in a finger becomes septic and 'blood poisoning' sets in, the glands in the armpit swell and become painful. Similarly with infected wounds in the foot, which affect the glands in the groin. In cases of cancer of the breast the cancerous or malignant processes travel along the lymphatic tracts and so reach the glands, which themselves become malignant. Tuberculous glands in the neck and elsewhere show the response of glands to infection, and confirm the great importance of this system in limiting the spread of disease.

Whilst it is not impossible that these glands produce some secretion which enters the circulation and has some specific effect on the organism, we are unable so far to make any definite statement in this connection, and must be content at present to regard them apart from the glands of secretion.

GLANDS WITH DUCTS AND EXTERNAL SECRETION

This system consists of organs set at various points in the body, the functions of which are to manufacture special products from the blood supplied to them, and to transfer these products, by means of conducting channels or ducts, to the particular place where their properties are of

greatest use. These glands develop as specialized outgrowths from those parts where their secretions will later be required. Among them are the salivary glands, the ducts of which open into the mouth; the liver and pancreas, the ducts of which open into the intestine; the tear and sweat glands, and so on. The stomach and intestines possess specially modified glands for the production of the gastric and intestinal juices. These glands with ducts leading from them produce secretions containing salts, and in many cases enzymes; and these are never carried directly into the blood.

Endocrine Glands

This system of glands comprises the thyroid, parathyroids, pancreatic islets, adrenals, sex glands, pituitary, spleen, and thymus.

These glands possess no ducts; each produces one or more characteristic hormones (internal secretions or chemical messengers) which are discharged directly into the circulation. A hormone is an active chemical substance which exerts a powerful influence upon the general metabolism of the body and, in some cases, on the activity of other glands. This latter point must be carefully kept in mind. For as our knowledge of endocrinology increases it becomes more and more clear that these glands react upon one another, and that diseases of one inevitably produce repercussions on the functions of the others.

Structurally these glands are distinct from one another, and there is no difficulty in distinguishing their characteristic architecture under microscopic examination. Each produces entirely different hormones; we do not yet know how.

THE THYROID GLAND.

This gland lies in the neck close to the windpipe, and consists of two lobes and a more or less well marked isthmus. It is, like all the endocrines, richly supplied with blood, and is made up of a supporting structure of connective tissue and a large number of little bag-like vesicles. In these we find, in the normal gland, a proteinous secretion called *thyroid colloid*, which is rich in iodine. The cells which line the vesicles have the property of abstracting from the blood the amino-acid 'tyrosin' (see chapter on Metabolism), and making it combine with iodine—obtained by the body from outside sources—to form di-iodo tyrosin. From this combination the cells produce the extremely important substance thyroxine, which they pass on into the vesicles where it is stored. Thence, under normal circumstances, it is liberated again at a slow, convenient rate into the blood. The gland thus manufactures the specific hormone thyroxine, stores it in its

vesicles in a convenient form, and frees it again directly into the circulation.

Thyroxine contains 65% of iodine, so that if adequate quantities of thyroxine are to be produced iodine must be provided in the food. The thyroxine, when liberated into the blood and thence into the tissues, produces certain effects (which we will soon consider) and in doing so the iodine in its molecule is split off and excreted in the urine, making it necessary continually to replenish the iodine in the body. The consequence of a deficiency of iodine in the diet will be considered when we deal with goitre.

If we wish to understand the function of an organ in so complex a system as the body, one way of doing so is to see what happens if it has had to be removed. Nowadays, when aseptic surgery has become so perfected, it is possible to remove almost any gland, and valuable knowledge has been thus gained. The problem of diabetes was solved in this way. But we must realize that the removal of an endocrine gland may lead to effects, not only due directly to a loss of one hormone, but due also to the overaction of other hormones, since these glands exert a control on one another.

In the case of the thyroid gland the effect of the removal of the gland differs at different ages. It will perhaps be simpler to tabulate the principal effects than to describe them at length.

Effects of Complete Removal of the Thyroid Gland

In the Young	*In the Adult*
Growth is greatly reduced.	Strength is lost
The patient remains sexually infantile.	Sexual life is partly diminished.
Growth of brain power is very slight.	The patient becomes sluggish, and anæmia develops.
Skin is thickened and hair is imperfect.	Skin is dry and hair falls out.
Temperature is below normal.	Temperature is low.
Basal metabolism is very low.	Basal metabolism falls.

Both the young and the adult recover normal existence on taking adequate amounts of dried thyroid glands by the mouth, or by injecting thyroxine, thus showing that it is the deficiency in the thyroid principle which is responsible for all the changes. Therefore, we conclude that the thyroid gland produces a secretion which is necessary for normal growth, development, and metabolism, and for the maintenance of normal adult life. Life can continue for a long time without this gland, but it is life at a low mental and physical level.

In considering the results consequent on removal of the thyroid gland, one striking thing is the fall in heat production or 'metabolic rate,' leading to the conclusion that the thyroid principle or hormone is essential to the processes of oxidation in the body. This view is strongly confirmed when we find that, on feeding animals with considerable amounts of thyroid substance or thyroxine, there follows a very marked rise in the metabolic rate and oxygen utilization, showing that the thyroid substance has stimulated the rate of oxidation in the tissues.

The influence of this gland is manifest in every function of the body, but it must be realized that its distant effects may be indirect, and due to its stimulation of the functions of other endocrine glands.

The control of the thyroid itself has long been a matter of controversy. It was considered until recently that it was controlled by the nervous system, but it is now generally accepted that it is not principally so governed, but is under the control of a secretion produced from the anterior lobe of the pituitary gland.

Diseases of the Thyroid Gland. Although the thyroid may be affected by inflammation and tumours, these are rare and not therefore of general interest. The three conditions of the thyroid most commonly seen are:

1. Simple or endemic goitre.
2. Under-action of the gland or hypothyroidism.
3. Over-action of the gland or hyperthyroidism.

Simple Goitre. This disease is simply an enlargement of the thyroid gland, and is particularly prevalent in districts where iodine is deficient either in the soil or in the food. The administration of iodine in any assimilable form is followed by cure or improvement of the condition.

Failure to obtain iodine may lead to enormous overgrowth of the gland, and consequent interference, through pressure, with the breathing and swallowing functions, but in most cases the enlargement of the gland is moderate.

This form of goitre is most frequent in regions considerably removed from the sea. Sea-water contains relatively large amounts of iodine, and from it the iodine passes into the air, and is thence, directly or indirectly, taken into the body. Marine plants and fish are also very rich in iodine, and are important in the prevention of goitre. But the question seems to be not simply one of iodine deficiency, for this form of goitre is also met with in regions where iodine is present in adequate amounts. In parts of India it has been considered to be due to an infective agent existing in the water, but this is not yet proved. Other factors have been suggested as contributing to its causation, amongst them being a dietary deficiency in Vitamin A (q.v.). Cabbage, sprouts,

and cauliflower have been suggested as contributory causes, as these are known to contain combined cyanides allied to certain others which have been found to produce goitre even when adequate amounts of iodine have been given. But whatever the theory of its causation there is no doubt that iodine given as a routine will usually go far toward curing the condition. The fish in one of the rivers of America possessed enlarged thyroids, but this phenomenon disappeared when small amounts of potassium iodide were added to the river water.

In human subjects the incidence of this endemic or simple goitre is found to be associated with a high incidence of deaf-mutism and mental deficiency, but large-scale experiments have shown that this, too, can be wiped out by adding iodine or iodides to the diet. It is only necessary to add potassium or sodium iodide to table salt in the proportion of one part in two hundred thousand to ensure protection. Iodine may be given in other forms, but this is the simplest and the best. In spite of the relative success which follows such treatment there remains much about the disease which is still very obscure.

This form of goitre is not necessarily accompanied by marked metabolic disturbance, but there are in individual cases tendencies to changes which may lead either to hypothyroidism or hyperthyroidism.

Hypothyroidism is a term applied to those conditions which are due to absence or deficient function of the thyroid. This condition, in various degrees of severity, may be present from birth, arise in very early life, or show itself in middle age. When it is present from birth it is frequently referable to deficient thyroid function in the mother, and the child presents in the main the features described above as occurring after removal of the thyroid in the young. This condition is called cretinism, and can be cured by administration of thyroid gland or its active principle.

When the corresponding condition occurs in the adult we call it *myxoedema*, which is characterized by a general depression of all the functions, mental and physical, with a marked thickening of the skin and the tissues below the skin. Enormous improvement occurs on giving thyroid gland as medicine. Intermediate stages between these extreme forms and normal thyroid function are also met with, and it is a test of the good physician to detect these types. Great benefit is almost always derived from giving thyroid gland preparations. Help in diagnosis and treatment is obtained by determining the basal metabolic rate (B.M.R.) which in these diseases is greatly depressed, values 50% below the normal being frequent. As treatment progresses the B.M.R. gradually or quickly approaches normal. If the treatment is stopped the conditions recur, a fact which has given to the process the name of Replacement Therapy, since it replaces a substance which the body is unable to produce itself. Giving iodine alone or as potassium

iodide is not of much use in these cases; it is the finished product, the thyroid hormone, which is deficient.

Hyperthyroidism. Too much thyroid hormone in the body leads to a train of well-marked symptoms, which can be brought about by simply adding a certain amount of thyroid gland substance to the diet of normal persons. The patient becomes excitable, loses weight, and develops tremors in the limbs; the heart beats quicker than normal, and the general metabolism of the body is greatly increased.

Many of us are familiar with the disease-picture of a rather young person (very frequently a girl) who complains of being 'very nervous,' whose limbs tremble a good deal, who looks rather flushed and is easily excited, who complains of palpitations, and whose eyes tend to bulge, so that she looks perpetually somewhat scared. This is the group of symptoms characteristic of what we now call hyperthyroidism. It is still often called exophthalmic goitre, but recent observations have shown that many of these cases have either no goitre in the neck, or no bulging of the eyes, so that the older term is unsuitable. The whole picture of hyperthyroidism is not frequently met with, but lesser manifestations of it are relatively common. Probably most people who complain of being 'highly strung' or 'nervous' are suffering from some degree of hyperthyroidism.

What is the complete picture of severe hyperthyroidism?

Not uncommonly it begins suddenly, and in youngish people; the subject becomes very nervous, and develops palpitation; in many cases the thyroid gland in the neck becomes enlarged, and its throbbing can be felt with the hand; the patient loses weight, complains of sweating, trembling, and great fatigue. He or she may have gastro-intestinal trouble; may vomit (a bad sign), whilst there is always a great rise in basal metabolic rate. The last point is very important in diagnosis, for of all cases showing a rise in B.M.R. the hyperthyroids constitute 90%. The state of a patient in a well-established severe case is pathetic; he or she lies in bed with a wild stare in the eyes, the heart beating at a rate which is often uncountable, the body shaking with tremors, whilst the slightest disturbance or shock sets up a condition of panic. What is the cause of all this? We know that it is associated with an over-acting thyroid gland, but what sets the over-action going? Quite frankly, we do not know. There is no doubt that there is often a history of a sudden shock or fright or emotional crisis before the onset of the disease. It has been known to arise after a disappointment in love. Sometimes we find a history of disease, but this is probably only a contributory cause. A constitutional factor is also suspected, but the whole subject is very obscure.

It seems probable that there is no single cause, but that a whole concatenation of circumstances suddenly conspire to break down a

weak link in the endocrine chain. There is no doubt, however, that the removal of part of the thyroid gland is followed in a short time by a great improvement. Until recently such an operation was undertaken by the surgeon only with great trepidation, because it was found that patients often died after what seemed like a very good piece of work. Nowadays things are much improved, and success is obtained in the vast majority of cases. The secret lies in what seems at first a paradox. The routine is this. The patient is put to bed, tended very carefully and completely rested: the basal metabolic rate is then determined. This is found to be very high; and for a few days a daily dose of a few drops of an iodine solution is given. It is now found that the patient is much improved, and the basal metabolic rate, instead of being 50% or 80%, is 20% or 40% above normal. At this point the surgeon is called in: he operates, and if proper care is taken after the operation, all is well. Nobody is very clear as to how this is brought about, but one thing is certain; when the removed gland is studied microscopically it is usually found to present features which are very nearly normal and the immense discharge of active thyroid hormone has been stopped. The iodine treatment described above is sometimes tried without operation, but its results are contradictory. Still, there is little doubt that the time is not far distant when this dread disease will come under the control of some purely medical form of treatment, without the help of the surgeon.

THE PARATHYROID GLANDS.

The parathyroid glands are four in number and lie in close contact with the thyroid gland, so that complete removal of the thyroid will, unless special precautions are taken, result in removal of the parathyroids also. Loss of the parathyroids alone is followed in mammals and in birds by a characteristic condition called.

Tetany. The symptoms of tetany are in general due to a great hyperexcitability of nerves: there occur spasms in the muscles of the jaw and face and peculiar contractions of the hands and feet: tremors and fits of convulsions occur in varying degree in different animals. In a few days death follows. For many years we had no definite knowledge of the function of the parathyroids, but chemical investigation of the blood has shown that when the calcium content of the blood falls to a certain level, symptoms exactly like those mentioned above occur. Calcium exists in the blood only in the fluid part, that is, in the plasma, not in the red cells, and the total amount is very small.

When parathyroid tetany occurs it is found that the plasma calcium falls to about one-half the normal, and if soluble calcium salts are injected into the blood the symptoms disappear and the animal for a time is better.

It seems, therefore, that the parathyroid glands in some way control the amount of calcium in the blood, and investigations have been carried out to see if these glands produce an active substance or hormone which, when injected into the animal, can prevent the consequences of loss of the parathyroids. Chemical investigation of the glands of animals showed that such an active principle could be obtained, and it has been named parathormone.

This substance (which has not yet been isolated in the pure state) can prolong life when the parathyroids have been lost.

We have already referred to the importance of keeping the saline composition of the blood satisfactorily balanced and have shown that proper functioning cannot be carried out if this balance is disturbed. In so far as the calcium salts are concerned, the parathyroid glands are clearly involved in this adjustment. Recent work has shown that they are also probably closely concerned with the maintenance of the balance of phosphates in the blood.

Calcium salts are taken both in food and in water. They are found in almost every organ in the body but mainly in the bones, and are excreted in the faeces and urine. Bone and tissue calcium seem to be in a constant state of flux. Normally the blood calcium is very constant, even when the patient is starved.

If the parathyroid hormone is injected into a patient with tetany, the blood calcium is raised to normal values, whilst a similar injection into a healthy individual leads to a rise in blood calcium far above the normal level, in some cases rising to twice the normal percentage. Just as a severe train of symptoms occurs with a great fall in blood calcium, so now the excessively high percentage leads to dangerous results. Congestion and haemorrhage in the stomach and intestine, and even death, follow.

Clearly this hormone is a very powerful one, but opinion as to how its effects are produced is not entirely unanimous. The simplest theory is that it acts directly on the bones, where it stimulates cells which liberate calcium from the bone into the blood. The importance of these glands has been recently stressed during the investigation of a peculiar disease called *generalized osteitis fibrosa.* This condition is a powerful, progressive disease of the bones which leads to fractures, deformities, and marked loss of calcium from the bones. Until lately little could be done with such cases, but it is now known that they are due to tumours of the parathyroid glands with resultant *hyperparathyroidism.* The consequence of this condition is the liberation of calcium from the bones in greater quantity than usual; the calcium in the blood increases and is carried off in greater amount by the urine, or it may be deposited in other parts of the body, such as the kidneys. Bone consists largely of calcium phosphate, so that when

the calcium is liberated from the bone a parallel loss of phosphate occurs. Good results in the treatment of osteitis fibrosa are reported from the removal of the parathyroid tumours.

Tetany in Cows. Milk is rich in calcium and phosphorus; hence it follows that during lactation there will be a considerable drain on the calcium and phosphate of the tissues. In the cow whose milk production has been artificially increased, this drain may be very great, and it is not surprising that it should sometimes give rise to symptoms of illness. Farmers call this condition of tetany 'milk fever,' and in some animals it is a source of great trouble. The cow develops convulsions and cannot stand, and unless immediate remedial measures are taken it will die. Certain cows are liable to this illness every time they calve, and wise farmers are prepared for its appearance. In most cases the cure is simply to blow up the udders with air so that the production of milk is stopped, the calf being artificially fed in the meantime. 'Milk fever' seems to be a tetany due to low blood-calcium content, following on excessive drainage of calcium from the body.

THE PANCREATIC ISLETS OR ISLANDS OF LANGERHANS.

The pancreas lies under the stomach, and is composed of two kinds of gland tissue. One part is responsible for the external secretion of the pancreas or pancreatic juice, which flows into the pancreatic duct, and so enters the small intestine; the other part consists of groups of cells or 'islets' (named after Langerhans), which produce an internal secretion called *insulin*, which enters the blood directly. Insulin is the hormone necessary for the proper metabolism of sugar. We have already discussed the metabolism of sugar, and pointed out that if this goes wrong the whole process of metabolism goes wrong. Let us consider the sequence of events in a normal man when we give him a sugar solution, say fifty grams of glucose. Before he takes the sugar his blood contains about one hundred milligrams in every one hundred cubic centimetres of blood. Let us express this fact by saying that his blood sugar is one hundred. He drinks the sugar solution, and in about an hour his blood sugar is about one hundred and sixty. In two hours or so his blood sugar is back to one hundred, or even less. There is still plenty of sugar being absorbed from the intestine, but his blood sugar is not raised. To deal with all that this simple experiment proves would involve too many technicalities. We can content ourselves with the statement that such a reaction to a dose of glucose is normal.

In the person with a defective insulin secretion, the sequence of events is quite different. Firstly, the initial blood sugar is higher than normal, it may be as high as three hundred or four hundred instead of one hundred. Secondly, the rise in blood sugar, when the solution is

taken, instead of being only sixty or so, may be two hundred or more. Thirdly, instead of returning to its initial level in two hours, the blood sugar keeps up at a very high level for several hours. Put briefly, the blood sugar is much higher to start with, rises to a much greater extent, and stays high for a much longer time. This is the characteristic reaction of a diabetic. When the blood sugar of a man rises above one hundred and eighty, the sugar passes from the blood into the urine, and this concentration of sugar in the blood is the condition called *glycosuria-threshold*—the point at which sugar passes out. Analysis of the whole phenomena has taken many years of research, and it may now be considered certain that it is the insulin from the pancreatic islets which keeps blood sugar normal and prevents the passage of sugar into the urine. When sugar is taken by a normal man the blood sugar rises to a level which, in that particular individual, stimulates the islets to secrete insulin. This passes rapidly into the blood and tissues, and prevents any further rise in blood sugar by means of two processes; first, the stimulation of the muscles to burn up the sugar; and secondly, the stimulation of the liver to store the sugar in the form of glycogen.

In a diabetic human being these processes are more or less defective according to the severity of the disease. In any case sugar is lost by the urine, and in the more serious forms of the disease all the sugar taken may be discarded in the urine. The two outstanding characteristics of diabetes are inability properly or completely to burn sugar; and inability to form glycogen. In the diabetic patient the injection of insulin restores the power to burn sugar and to form glycogen, but this re-establishment of function only goes on as long as sufficient insulin is injected. Insulin treatment is a replacement therapy, and not a cure. As long as the patient has diabetes, insulin must be continued in proper dosage. Furthermore, insulin must be injected by means of a hypodermic needle, because if taken by the mouth it is destroyed. The points raised in the consideration of diabetes and insulin are so many that we can only choose a few of the more outstanding, and give a short account of them.

Hyperglycaemia. This is the term used to denote a condition in which the sugar in the blood is greater than the normal. The diabetic patient has a persistent hyperglycaemia, and this leads to *glycosuria.* Insulin in proper dosage prevents hyperglycaemia. Insulin in too great dosage leads to too heavy a fall in blood sugar, so that concentrations result which are too low to maintain life.

Hypoglycaemia. If too large a dose of insulin is taken, or if the insulin is allowed to act unsupported by an adequate diet, the blood sugar may fall to very low levels. Should it fall to half the normal concentration, or less, a series of unpleasant symptoms is experienced,

and the patient may even become unconscious and pass into coma. This is called hypoglycaemic shock, and can be rapidly neutralized by the immediate taking of sugar. Every diabetic patient using insulin should carry some sugar with him in case this condition should occur.

One of the outstanding symptoms of diabetes is loss of weight. This loss will occur in the untreated diabetic no matter how generous his diet, and is due to the following fact. The untreated diabetic passes large quantities of sugar in his urine, and this comes not only from his food, but also from the breakdown of his own tissues. This process of forming sugar from the tissues is called *gluconeogenesis*, and in normal life is a normal process, but in diabetes it gets out of control, and in severe cases the patient loses weight rapidly. Insulin stops this uncontrolled gluconeogenesis so effectively that the patient soon begins to gain weight and strength, and can resume his usual work.

In very severe cases of untreated diabetes the patient may develop what is called *diabetic coma*, that is, become unconscious and suffer from 'air hunger.' The cause of this has been very much debated, but the most commonly held opinion is as follows. The failure to burn sugar properly results in failure to burn fat properly. As we have seen earlier, fats are normally burnt away to carbon dioxide and water, leaving no residues. In diabetes, however, the fatty acids are not burnt away without residue; certain substances are produced which the body cannot consume until insulin is given. These substances are acids, called diacetic acid and hydroxybutyric acid; they circulate in the blood of the diabetic patient, and are passed out into the urine. This acid-loaded condition is called *ketosis*, and if the ketosis is very severe the poisonous effects of the acids on the brain lead to coma and, if measures are not taken, to death. Ketosis disappears when the metabolism of sugar is restored to the normal by the injection of insulin.

The fundamental cause of diabetes is unknown, perhaps because there is no single cause. People who have for a long time eaten sugar to excess often develop diabetes; whilst there is probably some hereditary factor, since the disease tends to run in families. There may also be a contributory nervous condition, and recent research has shown that the pituitary gland, which lies at the base of the brain, produces a secretion which opposes the action of insulin. Other glands may be involved, possibly the thyroid, since it is found that hyperthyroidic patients often pass sugar in the urine. The adrenal glands, also, produce a secretion, adrenalin, which, when injected, leads to the appearance of sugar in the urine. Hence it may be assumed that, although diabetes can be completely controlled by insulin, the disease is probably in its origin polyglandular, that is, produced by disturbances of the equilibrium of several glands, of which the principal are the pancreas, the pituitary, the thyroid, and the adrenals.

One final point about insulin may be of interest. This hormone is sometimes used in the treatment of cases of loss of weight, loss of appetite, and certain nervous complaints, even though these may not be of obvious diabetic origin. A small dose of insulin is given once or twice a day, and this will, in some cases, stimulate the appetite, improve the general health, and increase weight.

THE ADRENAL GLANDS.

These two glands are situated one on either side of the abdomen in more or less close proximity to the upper parts of the kidneys. They are roughly pyramidal in shape, and consist of an outer rind or cortex, and an inner core or medulla. The two parts of the gland are distinct in structure, in development, and in function; and each part produces a characteristic internal secretion or hormone. That of the cortex has recently been discovered, and is called cortin; that of the medulla is called adrenalin, and has been known for a good many years.

The loss of both these glands leads in mammals to a characteristic train of symptoms, in many respects similar to that of the disease called *Addison's disease.* This disease is generally due to a tuberculous infection of the adrenal glands, and is fortunately rather rare. The symptoms are very striking. The patient becomes weak, loses appetite and weight, suffers from intestinal disturbances, and develops a dark pigmentation in the skin and on the palate: the blood-pressure falls to a very low level, and the blood sugar is also very much below normal. Inevitably death ensues in a short time.

It has been a question whether the symptoms are due to deficiency of the hormone of the cortex, or of that of the medulla, or of both. The injection of adrenalin produces only a very slight temporary relief, even when large doses are used, and lately it has been shown conclusively that it is the cortical hormone which is essential in the alleviation of the symptoms of Addison's disease, and of those following removal of the glands. Methods of extraction of cortin are still somewhat imperfect, so that large doses are at present necessary, but there is no doubt that the pure hormone will soon be available. The actual function of cortin in normal life is still being traced, but it would seem that its main importance lies in the regulation of the interchange of water and certain salts between the blood and the tissues.

We have already referred to the other secretion of the adrenal glands, adrenalin. This substance is of the highest importance. Although it is mainly produced in the adrenal medulla, it is widely distributed throughout what is called the autonomic nervous system. This system may be roughly defined as a specially developed system of fibres and ganglia, which carries the messages that control the functions of the internal organs. It is divided into two great groups, one arising

from the brain and lower end of the spinal cord, called the parasympathetic; one arising from the thoracic and lumbar spinal cord, called the sympathetic. The action of adrenalin is, generally speaking, to stimulate the sympathetic.

These two divisions of the autonomic are in continuous action, producing opposed effects, so that in the normal subject there is a constantly shifting balance between the two. The heart is slowed by the parasympathetic, and accelerated by the sympathetic; during excitement or fear there is a release of adrenalin; this stimulates the sympathetic, and the heart beats faster. The intestine is stimulated to contract by the parasympathetic, and to relax by the sympathetic; thus conditions leading to an increased production of adrenalin, among which is the emotion of fear, will produce a loosening of the bowel. The pupil of the eye is partly under the control of the parasympathetic and partly of the sympathetic, the former tending to contract the pupil and the latter to dilate it: hence fear and rage lead to a dilatation of the pupil.

The release of sugar from the glycogen in the liver is partly under the control of the sympathetic, so that during emotional disturbance, with the increased circulation of adrenalin there is an increased release of sugar, and hence a rise in blood sugar. The injection of adrenalin in fairly large doses will lead to the appearance of sugar in the urine.

The calibre of the smaller arteries is controlled through fibres arising from the sympathetic. Stimulation of such fibres by adrenalin leads to a constriction of these blood-vessels, and hence to a greater resistance to the blood-flow. The heart has to exert a greater force to pump the blood, and the blood-pressure rises. Here we see the importance of this hormone in the control of the blood-pressure; and in the maintenance of an efficient circulation. Other factors in this control are discussed in the section on the circulation, but it has been suggested that in cases of high blood-pressure the root cause of the condition is an over-activity of the medulla of the adrenal glands.

THE SEX GLANDS.

Although it was long suspected that these glands manufactured hormones, it is only in very recent years that any certain knowledge of this has been obtained. And even now, most of the work of research has been carried out on the female sex glands and their hormones, because the technique of testing their active extracts is easier. Our conception of sex is closely linked with that of reproduction, and we shall not err much if we regard sex glands and sex hormones as biological mechanisms for making easy and efficient the processes of reproduction of our species.

The sex glands (ovaries and testes) possess the double function of

producing the cells from which the new individual is to be developed, and the substances or hormones which make possible the successful union of the male and female cells. The former are, of course, the spermatozoa from the male, and the ova from the female. The mating of many animals is only possible at certain times, because except in the time of oestrus or heat the female will not receive the male. The rat and mouse will only receive the male every five or six days, whilst the guinea-pig will only do so every fifteen to seventeen days. The occurrence of such oestrus cycles depends on the presence of the hormones of the ovary in the female, and is manifested by definite and recognizable changes in the genital tract. In the periods between heat the vagina is not in a condition to receive the penis of the male: in the guinea-pig it is actually closed by a membrane during these times. During oestrus the vagina opens, its walls become turgid with blood, and its cells become harder, and it secretes a lubricating mucus. This period corresponds to that in which the ovum is discharged from the ovary. In an animal from which the ovaries have been removed the oestrus cycle is abolished; so that not only does it no longer produce ova, but it will not receive the male, that is to say, it does not go into heat. Such an animal is called a castrate. If we inject into such an animal certain extracts of the ovary from—say—the pig or the cow, it is found that the oestrus cycle can be re-established in all its phases. The substance or hormone responsible for this is oestrin, and is a definite chemical compound. It is present in human female blood and urine as well as in those of other animals.

Consider the ovary for a moment. When the ovum has been discharged from its follicle or shell on the ovary, the space is soon filled with blood; and this blood undergoes certain changes which transform it into a more or less yellow pigment. This yellow-pigmented follicle is called a corpus luteum, and is of great importance. It secretes a hormone which has a special action on the wall of the uterus. The secretion of the corpus luteum may be called the hormone of nidation, or nest-making hormone. The uterine lining thickens, becomes rich in blood-vessels, and is in other ways prepared to receive the fertilized ovum. What happens next depends on whether or not the ovum is fertilized by the spermatozoon, i.e. whether a young animal is going to develop or not.

If fertilization does not take place the ovum degenerates, the corpus luteum degenerates, and the prepared lining of the uterus is thrown off and is got rid of by menstruation. Menstruation may be regarded as a protest against non-fertilization.

If fertilization does take place the ovum and spermatozoon unite together into what finally becomes the offspring, this union and development taking place in the uterus. In such a case the corpus luteum

persists, and grows, and may even come to occupy one-third of the whole ovary. This persistent corpus luteum is called the corpus luteum of pregnancy, and its removal leads to the termination of the pregnancy, that is, either the developing infant is expelled or it degenerates. It would seem, therefore, that the corpus luteum produces some internal secretion, which is essential for the establishment and continuance of pregnancy. As long as the corpus luteum persists, the mother does not release any more ova from the ovary, and will not menstruate, showing that the action of the corpus luteum is to oppose ovulation and menstruation. In addition to these functions, it controls the growth and development of the mammary gland during pregnancy, bringing it to a state in which it can produce milk.

These functions of the ovary and the corpus luteum are themselves dependent on the proper action of the pituitary gland with which we shall deal next, the anterior lobe of which produces a secretion which controls the activity of these bodies. In the urine and blood of a pregnant female it is possible to detect a substance similar to that produced by the anterior lobe of the pituitary, and perhaps identical with it. The presence of the 'anterior-pituitary-like' substance in the urine can be shown by injecting extracts of the urine into immature mice, that is, mice which normally could not yet develop oestrus, when in a few hours the animal will develop unmistakable signs of ovarian activity and corpus luteum formation. By this test we can ascertain whether a woman is pregnant, as it gives reliable results before there is any evidence of pregnancy discoverable by external methods of examination. This substance is, of course, present during the ordinary ovarian cycle, but the increase is so great during pregnancy that detection is positive with much less material. This test is now a routine in hospitals and clinics, and very rarely gives misleading results.

The male sex hormones are equally important. The removal of the testes from any male animal is followed not only by the loss of fertilizing power, but also by the loss or modification of the characteristics associated with the male sex. The physical appearance of the eunuch is well known, while the production of 'castrati' in the Middle Ages and later, in order to retain the treble voices of young male singers will also be recalled. In young castrated rats the penis and accessory organs of generation remain infantile, and the young cockerel, if deprived of his testes, does not develop the large red comb, wattles, and barbels which we associate with the full-grown cock.

There is now no doubt that the testes produce a substance, which appears to be identical in all species and is allied in composition to oestrin, which re-establishes the male characteristics of the castrated male. The implantation of testicular tissue will produce similar results. It should, however, be remembered that the re-establishment

of the male characters in a young castrated animal is not the same as rejuvenating an aged subject.

THE PITUITARY GLAND.

The pituitary is a small gland weighing about half a gram. It lies well protected in a depression of the sphenoid bone at the base of the brain. The influence of this tiny organ upon the most diverse processes in the body is almost incredible. In the human subject it is composed of two principal parts, the anterior and the posterior lobes. Microscopically, the anterior lobe is composed of cells which are arranged in gland form, but the posterior lobe is composed of cells, closely resembling nervous tissue, from which we should not ordinarily expect a secretion.

The Posterior Lobe. This is the easier to consider briefly, because so far as is known it produces only two active principles. Until lately it was thought that it produced only one active body, pituitrin, but this has now been split into two distinct compounds called pitressin and pitocin. In ordinary medical work the combination of the two as pituitrin is commonly used. The three results which it brings about correspond with the natural functions of the posterior pituitary. It is used in medicine:

(1) In raising the blood-pressure in cases of heart failure and collapse, showing that the posterior pituitary is one of the controllers of the blood-pressure.

(2) In the treatment of cases of *diabetes insipidus*. In this condition enormous amounts of urine are produced and correspondingly enormous quantities of fluid are drunk. This disease is distinct from ordinary or sugar diabetes. Sugar is not found in the urine of sufferers from diabetes insipidus. It is probably due to a depressed activity of the posterior pituitary, and adjacent parts of the brain. The injection of pituitrin is very helpful, and in some cases leads to complete control of the symptoms.

(3) In the delivery of pregnant women. In the later stages of labour when there is no obstruction to delivery, but the womb does not contract strongly enough, the injection of a relatively small dose of pituitrin will produce strong contractions, and the child is often expelled very quickly.

There would seem to be little obvious connection between a small gland at the base of the brain and the control of the contraction of the womb and the formation of urine. This should remind us again of the close connection between nervous action, emotion, and organic function. The mind probably exerts no small control over the functions of the endocrine glands. Every doctor knows how much

easier some confinements are than others which appear physically similar, and it is possible that the mental attitude in the one case may stimulate the activity of this important gland, and so produce sufficient pitocin to contract the womb effectively.

The Anterior Lobe. This is composed of three types of cells in a gland-like arrangement. The distinction between these cells is one which can only be established by the microscope. They are called according to their readiness to stain with certain substances: chromophobe cells, acidophil cells, and basophil cells. More than in the case of any other gland, our knowledge of the anterior pituitary has been obtained from the study of human disease by correlating such disease with changes found in the gland after death. The result is that we can now state with some confidence what particular function is performed by each type of cell in this part of the gland.

The acidophil cells produce a hormone which stimulates the growth of the body in general, but particularly that of the bones and muscles. This growth-promoting action has been shown by the preparation of extracts of the anterior pituitary, which have produced in treated rats enormous overgrowth.

In the human species we meet, now and again, with examples of giants and dwarfs. These unfortunate abnormals are generally found as exhibits in shows and fairs. The X-ray photographs of the insides of the skulls of these subjects show in giants definite evidence of an enlarged pituitary gland, and of the reverse in dwarfs. A peculiar disease called acromegaly gives further proof of this function of these cells. This ailment attacks the patient slowly; his limbs and the bones of his face become enlarged and thickened; the tongue swells, the lower jaw becomes prominent and gradually the whole individual changes. Sex-life ends, and he becomes impotent. If the condition arises before the subject is full-grown he may develop into a giant, but an unhealthy one. Sometimes sugar diabetes accompanies this disease. Acromegaly has been definitely shown to be due to a tumour of the anterior pituitary, composed of acidophil cells. Surgical removal of such a tumour is very difficult, but in certain cases it has been successfully done with marked improvement. The growth of such a tumour, apart from producing excessive overgrowth of the body, also interferes with the function of the other parts of the gland.

The basophil cells elaborate an active principle which controls the activities of the ovaries and the testes. Failure of these cells to develop leads to a cessation of the development of sex characters, and we get what is called sexual infantilism. The proper establishment of the sexual cycle of oestrus and of the corpus luteum are directly dependent on the basophil cells of the anterior pituitary. Thus we may see how overgrowth or tumour of the acidophil cells in acromegaly, with its

consequent compression of the basophil cells, may lead to disturbances of sexual function and to impotence.

The function of the chromophobe cells is at present unknown. In certain cases of tumour and overgrowth of these cells there may follow compression of the other elements of the anterior pituitary and consequent dwarfism and maldevelopment of sex. Such tumours often lead to impairment of vision, since the pituitary gland lies in close relation with the optic chiasma, that is, the crossing-place of the optic nerves.

Recent research has demonstrated that the pituitary exerts control over the thyroid, and the adrenals, and also produces a hormone which antagonizes the action of insulin. The whole subject of the ductless glands is of vast complexity, and we can only state here that the entire life of the organism seems to be regulated by an interplay of a great number of chemical agents, produced by special glands, and so balanced one against another that what is called normality results. In the complicated interactions the pituitary may be called the master gland.

VII—THE SPECIAL SENSE ORGANS AND THEIR DISORDERS

The Eye

The human being who has lost his sight is very heavily handicapped in the competition of life, and, as the necessity for a broad field of vision presupposes that the organ of sight must be placed on the surface of the body in a relatively exposed position, it will not be found surprising that it is a very complicated mechanism, and includes several devices, such as eyelids, tearducts, etc., which are designed to protect it from damage from trivial causes. These protective devices will be described later, after the eye itself has been dealt with. In addition to the eye, the apparatus of sight includes the optic nerve and the occipital lobes of the brain. Briefly, the process of seeing is as follows: The eye forms pictures of the objects in its field of vision, the optic nerve then carries these impressions to the brain where they are received and interpreted, and the messages they convey are passed on to the body if necessary. We each possess two eyes, identical in function, though individual variations in the working of the two eyes occur with great frequency. Each eye registers the same picture, and transfers it by the same process to the brain, where the two impressions are correlated and interpreted, each strengthening and supplementing the other. The two eyes are situated in deepish hollows in the front of the skull at each side of the head. These cavities, or orbits, as they are called, are designed to form protection for the soft and easily damaged eyeball and its accompaniments, such as the optic nerve and the muscular tissues which serve to move the eyeball in different directions. The bone of the margins of the orbits is very strong and can withstand a hard blow which would destroy the eye if it were not thus protected. The general structure of the eye is described elsewhere in this book. Here it is proposed to summarize such of the facts as will help to make clear what follows.

THE EYEBALLS.

The eyeball is the major part of the eye. It is ball-shaped with a slight bulge in the front. This bulge is called the *cornea*, and is the window of the eye through which the picture-images of the outside world come. In a healthy state the cornea is a perfectly transparent

membrane. Underneath the cornea lie the *iris*, or coloured part of the eye, and the *pupil*, or black centre of the eye, which is simply a round hole in the centre of the iris. The eyeball is covered by three layers of tissue. The outer layer, which is called the *sclerotic*, covers the entire surface of the eyeball. It is composed mainly of firm white opaque tissue, from which it takes its popular name of the 'white of the eye.' At the front of the eyeball, however, this tissue undergoes a change in composition, becoming transparent instead of opaque, and this transparent tissue forms the *cornea*. The cornea should be perfectly transparent if it is to carry out its function of transmitting rays of light. In order to ensure that no irritating substance or foreign body shall remain on its surface long enough to impair it, the cornea is well supplied with minute nerve-fibres, and therefore very acute pain is caused when anything alights on its surface, or finds its way under the upper lid. This pain usually ensures that immediate steps will be taken to remove the cause of irritation.

THE AQUEOUS AND VITREOUS HUMOURS.

The eyeball is divided into two parts, with the lens as the dividing wall. Each division contains fluid or jelly-like matter in cavities. In the front cavity of the eye, between the iris and the lens, the fluid is clear and thin, and is known as the aqueous humour. It is of the greatest importance in maintaining the proper balance of pressure in the eyeball. A drainage canal, known as the canal of Schlemm, acts as an overflow reservoir to avoid undue increase of pressure. In the rear cavity, which is the larger of the two, and lies behind the lens, the fluid substance is of a firmer and more jelly-like consistency. This substance is known as the vitreous humour. It is sparkling and transparent, and plays an important part in the process of the refraction of the rays of light.

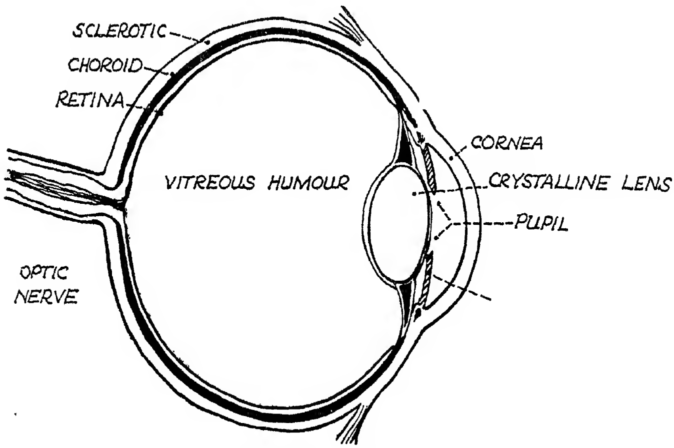
THE CHOROID.

The second layer of tissue in the eyeball is called the choroid. It contains much colouring matter, and is permeated with blood-vessels. The black pigment in the choroid serves to absorb the diffuse rays of light, which would otherwise dazzle the sight, and confuse the images observed. This dark pigment is absent in the persons and animals known as albinos, and it is well known that their sight is very dim and defective. This is especially so during the day, when they are in a state of dazzlement by the strong rays of daylight. In twilight they can usually see slightly better. As the choroid reaches the front of the eye it becomes thickened and raised up into numerous tiny ridges, which are called the ciliary processes, or ciliary body. These ciliary processes

consist of blood-vessels and circular muscles, and they form a circular rim to the iris, into which the choroid merges in the centre of the eye in the same way that the sclerotic merges into the cornea in the outer layer of the eyeball. The iris, or coloured part of the eye, acts as a light regulator for the pupil through which light passes into the eye. The circular muscles allow the pupil to be contracted or expanded according to how much light it is desirable should enter the eye. The pupil is, as has been stated, merely a circular gap in the tissue of the iris. It appears black because of the dark tissue behind it.

THE LENS.

Immediately behind the iris is found the lens. As its name suggests, its purpose is to focus the rays of light which enter the eye and throw them upon the retina, which lies behind in the third layer of tissue.



DIAGRAMMATIC SECTION OF EYE

The lens is composed of crystalline transparent material, and is enveloped in a capsule. This capsule is formed of elastic tissue, and continues from the lens to the ciliary processes, so that the lens, which is a double convex body with the larger convexity to the back, can be said to be suspended in the depths of the eye. The action of the ciliary muscle and the elasticity of the suspensory tissue allow the lens to become more or less convex as required in order to focus objects at different distances. This power is called the 'power of accommodation,' and it is to correct defects in accommodation that most people obtain spectacles, especially as they grow older and the ciliary muscle begins to fail.

THE RETINA.

The third layer of the eye is that formed by the retina. This is the most delicate and intricate layer, and is composed of cells of very specialized tissue, which forms the ends of the optic nerve-fibres. These fibres enter the eye at the back in a large bundle, and then spread out in every direction and form a membrane covering the surface of the choroid. The structure of the retina is very complicated. The cells of which it is composed are of a variety which is found nowhere else in the body, and their special characteristic is their sensitivity to light. In shape, the most important groups of cells are minute elongated cells, which are known as the rods and cones. These are found in the deepest part of the retina, and are attached to the fibres of the optic nerve, which carries the impressions of light to the brain. It has been discovered by means of the microscope that the tissue of the retina is at least nine layers deep, so that a ray of light passes through many processes before it is finally collected by the rod- and cone-shaped cells, and transferred to the brain to become an impression of sight.

Not all parts of the retina are equally sensitive to light. The mid-point is the most sensitive area. On examination with a powerful lens this area appears as a yellowish stain, and is called the macula or macula lutea. The spot where the optic nerve enters the retina is quite insensitive, and is known as the optic disk, or in popular language, the 'blind spot.' The instrument by means of which the eye of a living person can be examined is called the opthalmoscope. When seen through the opthalmoscope the retina appears bright ruby red, with the yellowish macular area in the middle, and the pinkish area of the optic disk at one side. From the optic disk, blood-vessels radiate in every direction to the different parts of the retina, and the nerve-fibres of the retina come together to form the optic nerve.

THE WORKING OF THE EYE.

To recapitulate: The eye is very often compared to a camera. A camera is used to collect impressions of objects and focus them on to a plate, from which the impressions are printed off on to paper, when they can be seen. The eye similarly is used by us to gather impressions of the external world and focus them by means of the lens on to the retina, whence they are conveyed to the brain, which performs the acts of interpretation which allow us to 'see' them. The choroid may be compared to the box or black cloth which cuts off the reflection of light which would otherwise spoil the clearness of the picture. The iris acts as the stop and shutter, allowing the pupil to open more widely in a poor light, and closing it when sufficient light is entering. The lens focuses the objects to be seen, and throws them on to the retina.

In addition to the different parts of the eye itself, there are many

muscles and nerves required for its effective use. These allow the eye to move from side to side, up and down, and with a circular movement; thus ensuring a very large field of vision. In view of the fragility of the various structures of the eye, the nerves of sensation with which most parts are well supplied are very sensitive, so that any damage to the eye is apt to be very painful. Moreover all parts of the eye are plentifully supplied with arteries and veins, so that it shall be properly nourished. Because of this network of delicate vessels the state of the blood-circulatory system is of great importance to the eye. Increased blood-pressure, causing intra-ocular tension, can have very serious effects on the sight, as in the case of the disease known as glaucoma.

In order to have good eyesight, it is necessary that the cornea and retina shall be clear, and that the eyeball shall be well shaped. Otherwise, such irregularities as myopia, hypermetropia, and astigmatism will be present. The apparatus dealing with accommodation must also be in good working order. There are comparatively few perfect eyes in the world, but a great many people manage very well throughout life with a small degree of imperfection, and many of the others have their faults corrected by the use of glasses.

THE EYELIDS.

The eye is protected behind and at the sides by the bone of the skull, and in front by the eyelids. These are two flanges of skin strengthened by a thin sheet of cartilage and lined with mucous membrane. This membrane is called the conjunctiva, and the mucus it excretes from its glands serves as an oiling fluid to enable the eyeball to move easily and without friction in the socket. The eyelids protect the eyeballs from too great exposure to the light, and from damage by external objects, such as dust particles, blows from raindrops, etc.

THE TEAR GLANDS.

In the upper and outer part of the eyeball are the lachrymal or tear glands. These produce the salty fluid which we know as tears, and help to keep the eye moist and clean. These glands pour out fluid which bathes the front of the eye, and flows away into little canals called the canaliculi. The canaliculi have their openings at the corner of the eyelids near the nose. They lead to a little bag called the lachrymal sac, and from thence pass into the nose. This forms a neat and complete system of washing and draining for the eye, but when a thorough sluicing-out is required, as in the case of dust in the eye, a larger quantity of fluid is poured out than the tear sacs can collect at the moment, and we have the phenomenon of tears flowing down the face. If the tear ducts become blocked there may be a temporary state of 'watering of the eye.' If this becomes chronic it will have to be remedied by a slight operation. The tears

contain sodium chloride, or common salt, which has a slight bactericidal action, so that they protect the eye in some measure from the danger, to which it is constantly exposed, of infection by bacteria-laden dust.

Disorders of the Eye and Eyelids

BLINDNESS.

When the power of sight is destroyed, a person is said to be blind; but there are many degrees of dimness of sight short of total blindness. A certain number of persons are born blind, and if their blindness is due to structural defects there may be nothing to be done for them, but a large proportion of the children who are labelled blind from birth could have been saved this misfortune with proper care and treatment in the early days of life. Blindness is often due to inflammation of the eyes which is present at birth, or arises shortly after, and is not properly treated. This ophthalmia neonatorum, as it is called, can usually be cured or avoided if reasonable antiseptic precautions are adopted at the time of birth and afterwards, especially when it is known that the mother has a vaginal discharge with which she is likely to infect the child.

Any disease which causes the transparent parts of the eye, such as the cornea and the lens, to become opaque, diminishes or entirely obscures the sight. Of these cataract and affections of the cornea are the most common. Other causes of loss of sight are to be found in diseased conditions of the nerve-supply of the retina, of the optic nerve, or of the lobes of the brain which deal with sight. Partial or total blindness, either temporary or permanent, may occur as a symptom of many general diseases, such as nephritis and diabetes; and of certain brain diseases, such as cerebral tumours; whilst hysteria and migraine commonly have ocular symptoms. Sight may also be injured or destroyed by injuries to the eye which appear comparatively trivial. Many drugs, such as opium, tobacco, quinine, alcohol, and others may cause irregularities of sight. *Tobacco blindness* is, in fact, comparatively common in slight degrees, and occasionally proceeds quite suddenly to complete blindness. The cure is the obvious one of discontinuing the use of tobacco. The results are often sensational, in the rapidity and completeness with which the sight returns to normal.

Colour Blindness. The condition known as colour blindness, in which an individual can distinguish the shape and size of objects normally, but does not perceive the usual range of colours, is a congenital and, usually, a hereditary one. It is thought to be due to some defect of the retina, and so far no cure for it is known. In different persons it is present in different forms, but the commonest defect is in the perception of red and green, which may be confused with each other. As these